1970

Bear River Investigations: Idaho, Utah, Wyoming: Summary of Status Report, June 1970

Bureau of Reclamation; United States

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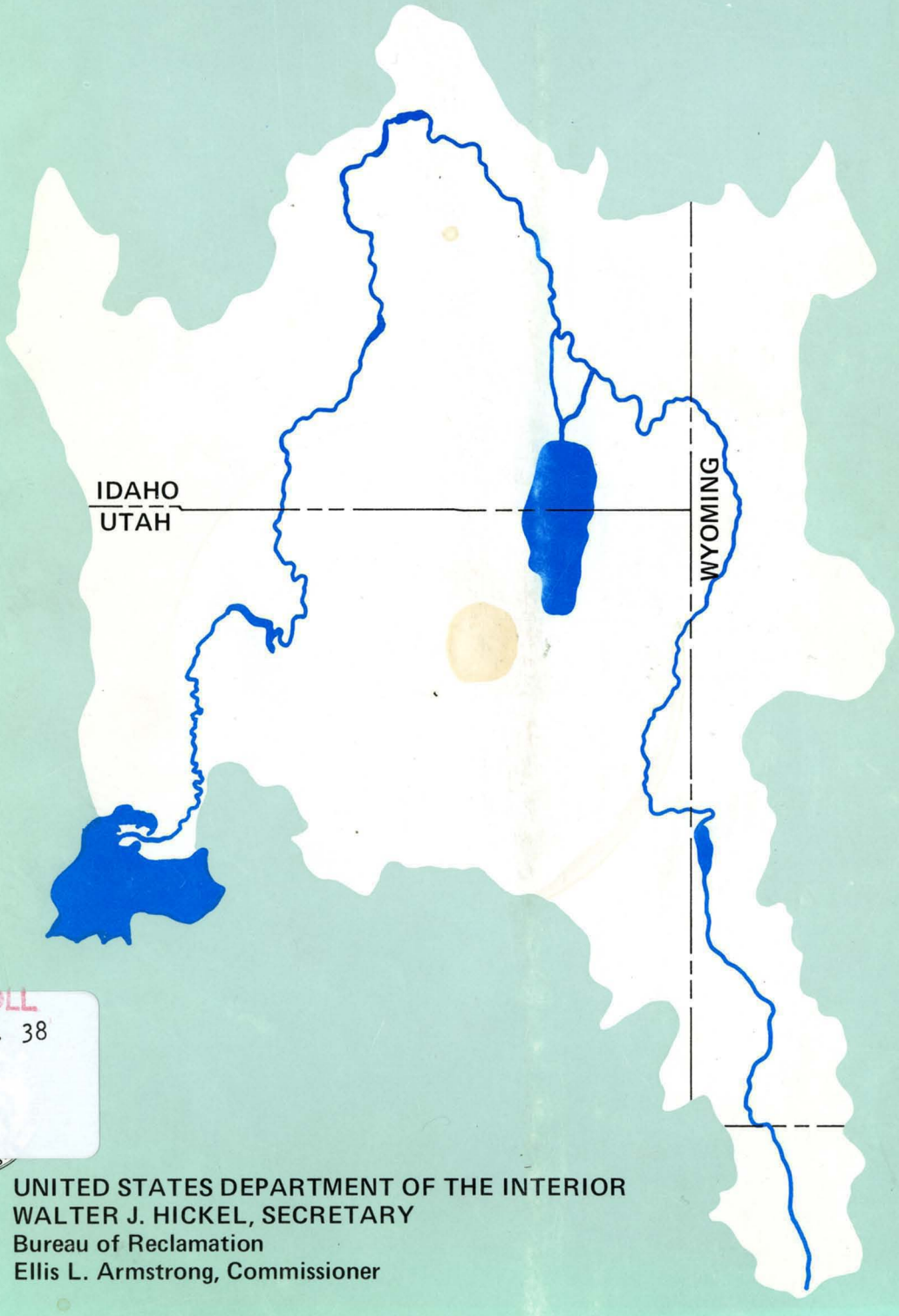
BEAR RIVER INVESTIGATIONS

Status Report

June 1970

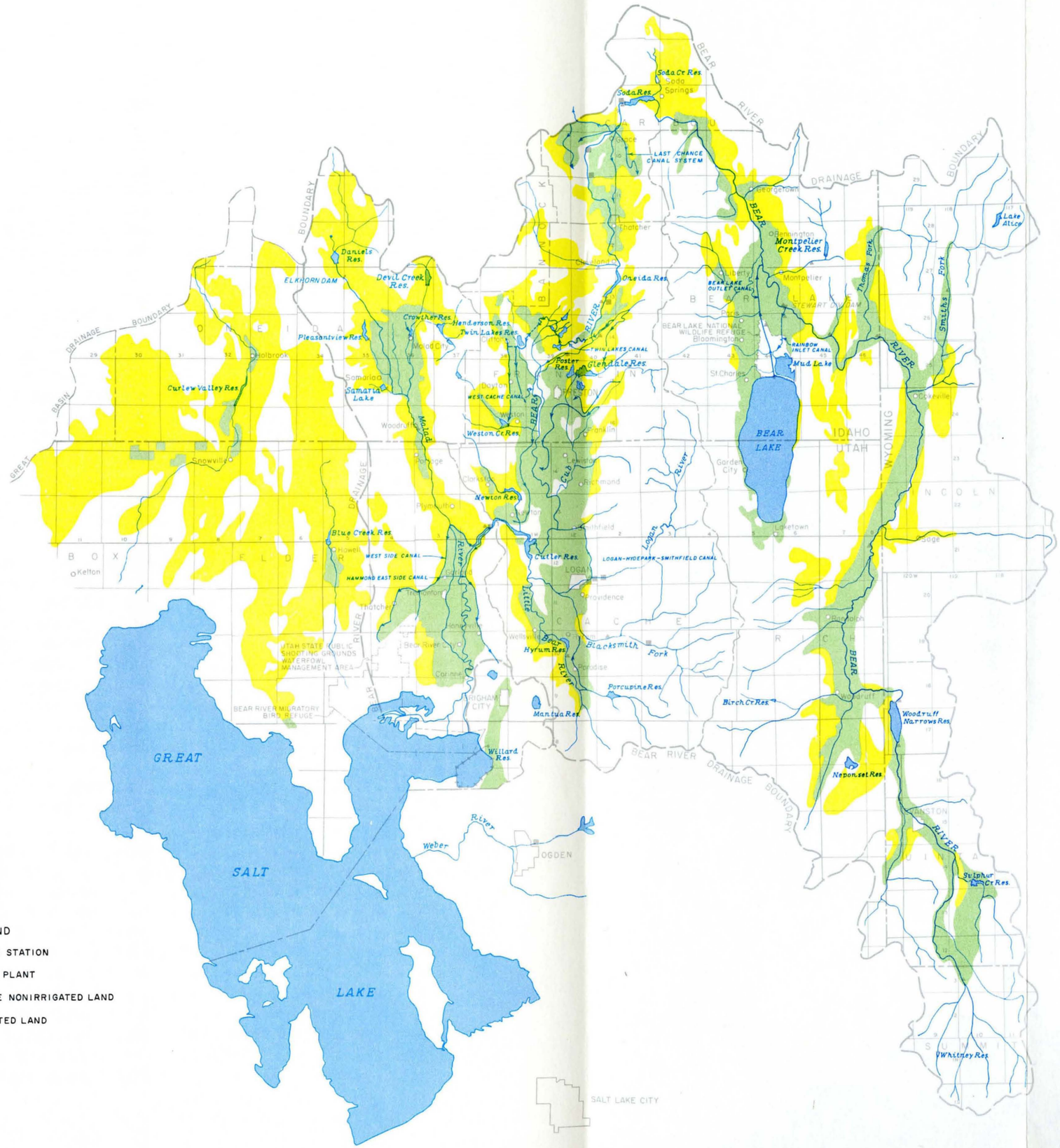


UNITED STATES DEPARTMENT OF THE INTERIOR
WALTER J. HICKEL, SECRETARY
Bureau of Reclamation
Ellis L. Armstrong, Commissioner

BEAR RIVER INVESTIGATIONS
Idaho, Utah, Wyoming

Status Report
June 1970

Bureau of Reclamation
Ellis L. Armstrong, Commissioner
David L. Crandall, Regional Director,
Region 4, Salt Lake City, Utah


Soda Cr Res.
Soda Res.
Soda Springs
BEAR RIVER
LAST CHANCE CANAL SYSTEM
DRAINAGE BOUNDARY
Georgetown
Thatcher
Daniels Res.
ELKHORN DAM
Devil Creek Res.
Oneida Res.
BEAR RIVER
Montpelier Creek Res.
Lake Alice
Thomas Fork
Smiths Fork
Montpelier
BEAR LAKE OUTLET CANAL
STEWART DAM
Crowther Res.
Henderson Res.
Twin Lakes Res.
Pleasantview Res.
Holbrook
Malad City
TWIN LAKES CANAL
Poster Res.
Glendale Res.
BEAR LAKE NATIONAL WILDLIFE REFUGE
Bloomington
RAINBOW INLET CANAL
Mud Lake
St.Charles
Curlew Valley Res.
Samaria Lake
Dayton
WEST CACHE CANAL
Weston
Malad
Weston Cr Res.
Franklin
BEAR LAKE
IDAHO
UTAH
WYOMING
Ockeville
Snowville
Portage
Newton Res.
Plymouth
Richmond
Gardel City
Logan
Blue Creek Res.
Howell
WEST SIDE CANAL
HAMMOND EAST SIDE CANAL
Cutler Res.
LOGAN-HYDEPARK-SMITHFIELD CANAL
Smithfield
Laketown
Sage
Kelton
Tremonton
Providence
Hyrum Res.
Blacksmith Fork
Porcupine Res.
Paradise
Birch Cr Res.
Woodruff
Woodruff Narrows Res.
UTAH STATE PUBLIC SHOOTING GROUNDS WATERFOWL MANAGEMENT AREA
Corinne
BRIGHAM CITY
Mantua Res.
BEAR RIVER MIGRATORY BIRD REFUGE
Willard Res.
Neponset Res.
BEAR RIVER DRAINAGE BOUNDARY
GREAT
SALT
LAKE
Weber River
OGDEN
Sulphur Cr Res.
Whitney Res.
SALT LAKE CITY
LEGEND
GAGING STATION
POWER PLANT
ARABLE NONIRRIGATED LAND
IRRIGATED LAND
N
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGION 4
BEAR RIVER INVESTIGATIONS
IDAHO-UTAH-WYOMING
GENERAL MAP
MAP NO. 475-415-320
DECEMBER 1969
10 0 10 20
SCALE OF MILES

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FOREWORD

With a view of providing assistance to the States of Idaho, Utah, and Wyoming and others who are actively interested in further development of water and water-related resources of the Bear River Basin, the Bureau of Reclamation has compiled this volume based on its cooperative investigations extending over many years. Although no comprehensive basinwide development plan is presented, a number of potential projects, including some alternatives, are described. Some of these projects could fit into a unified plan. In a sense this report summarizes the findings of the Bureau during its extensive studies in the Bear River Basin. Much of the investigation and planning work has been done to detailed feasibility standards, and some has been done only in reconnaissance scope. Development concepts for distant future developments, not yet explored, are also mentioned.

Early water developments in the Bear River Basin were made by private interests. More recently the Hyrum, Newton, and Preston Bench Projects on Bear River tributaries were constructed as Federal reclamation developments. Of late two small reclamation projects were constructed in Malad Valley. The State of Utah sponsored construction of the Woodruff Narrows Project on the upper Bear River and the Porcupine Project on Little Bear River and is currently constructing the Woodruff Creek Dam on Woodruff Creek. The Wyoming Natural Resource Board constructed the Sulphur Creek Dam in 1957 and enlarged it in 1964. The Montpelier Creek Dam is being constructed by the Soil Conservation Service.

The potential for further development is great. Although much of the river flow passes through from one to five hydroelectric powerplants, a large part of the water is not consumed in other beneficial uses. About 824,000 acre-feet of Bear River water annually still flows into Great Salt Lake where it eventually evaporates while large areas of the basin's irrigated lands have inadequate water. Part of the lake inflow is usable at the Bear River Migratory Bird Refuge and other refuges on the lakeshore, but the supply is not seasonally timed with the needs of the refuges so that much of it has little or no value for that purpose and the refuges do not have enough water during periods of greatest need.

The favorable physical opportunities for further Bear River development are accompanied by complexities resulting from the many different interests in the river basin. Each of the three States that contribute water to the river system naturally has a separate interest in development plans. Residents of each of the five valleys through which the river flows also have separate interests as do property owners near Bear Lake, which serves both as the principal storage reservoir on the river system and as a major recreational attraction. The Utah Power & Light Company is involved because of its five hydroelectric powerplants along the river's main stem. Fish and wildlife interests range from stream and

reservoir fisheries to large Federal and State refuges dependent on river flows. The Bear River Compact, although useful in defining water rights, has not led to a consensus on development plans.

Further water developments intended to satisfy the greatest needs of the basin's people, will be limited by water supply, water rights including compact provisions, favorable structural sites, and economic and environmental considerations. A reasonable hope is that plans can be adopted and carried out that will bring a worthwile measure of benefit to the area. An approach to this objective appears to be in progress by responsible interests in each State. The official water resource agencies of the States are conducting studies and have established administrative means for interstate consultation. The Bear River Commission established by the Bear River Compact includes representatives of each of the three basin States and the United States. The Commission provides a formal entity for continuing communication and cooperation among the States.

Support of residents of the basin and of public officials at local, State, and Federal levels is needed to obtain project construction authorizations. Agreement among the States on development plans would be particularly important. Early agreement would expedite greater river development and realization of benefits from use of the water.

Authority for the Bear River investigations and the issuance of this report is granted in Federal Reclamation Law (Act of June 17, 1902, 32 Stat. 388, and acts amendatory thereof or supplementary thereto).

CHAPTER I

SUMMARY AND CONCLUSIONS

The Bear River Basin constitutes the northeastern part of the Great Basin, a large semi-arid region in western America, where the streams flow inward from the basin rim and are eventually dissipated by evaporation. Throughout the Great Basin water is generally in short supply and is often the limiting factor in the potentials for economic development. In most parts of the Great Basin surface streams are approaching full control and utilization and in a number of instances are supplemented by importations of water across the basin rim.

In water resources the Bear River Basin is one of the more richly endowed parts of the Great Basin but perhaps the least developed except for hydroelectric power generation. In the past 50 years limited development, except for power, has been made on the main stem of the Bear River. During this period a number of important projects have been constructed, mostly on tributary streams, but these have not greatly reduced the unconsumed flows of Bear River.

Population growth has also lagged in the Bear River Basin. The basin's residents numbered 78,000 in 1960, only 12 percent more than in 1920. During this period populations of Idaho increased 55 percent, Utah 97 percent, and Wyoming 70 percent. Population growth rates are an important index of economic growth. Greater water resource development in the Bear River Basin undoubtedly would have contributed to a greater population increase.

Water Needs

Needs for additional water in the Bear River Basin for irrigation, municipal, industrial, fish, and wildlife uses far exceed the basin's unconsumed water resources.

More than 2 million acre-feet of water annually at points of diversion would be required to supplement present water supplies in providing full irrigation service to the approximately 1 million acres of arable land in the Bear River Basin. About half of this land is presently irrigated. Irrigation of all of the land would not be physically or economically practical under present conditions even if enough water were available in the river. Supplemental water for many existing farm areas is urgently needed, however, and progressive expansion of irrigation is required for the economic well-being of the people.

Municipal and industrial water supplies, not now taxed by surging population growth or industrial expansion, are adequate for present needs

in most parts of the basin. Some communities will need more water for normal growth and substantial needs are expected for industrial developments such as expanded phosphate production along a tri-state reach of the river above Montpelier, Idaho, and mineral extraction from Great Salt Lake. Additional basin needs for municipal and industrial water will probably amount to about 150,000 acre-feet annually by year 2020.

Fish and wildlife interests require 300,000 to 400,000 acre-feet of regulated water annually for existing and potential refuges. This water would supplement present supplies.

Water Supply above Bear Lake

The Bear River Compact of 1958 limited new storage above Bear Lake to 36,500 acre-feet. Reservoirs having capacity to develop approximately 31,250 acre-feet have since been built to serve lands in Utah and Wyoming, leaving an undeveloped balance of only about 4,250 acre-feet available to Wyoming and 1,000 acre-feet to Idaho. The Bear River Commission is considering the advisability of recommending a compact amendment that would permit additional storage above Bear Lake.

Bear Lake and its satellite, Mud Lake, with a combined conservation storage capacity of 1,452,000 acre-feet, can be operated to provide full practical control of Bear River flows originating above Stewart Dam which diverts the river to these lakes. The lakes are operated by the Utah Power & Light Company under provisions of the Bear River Compact. The power company maintains the Lifton Pumping Plant at the Bear Lake outlet. The compact provides for an irrigation reserve in Bear Lake which shall not be released solely for power generation at the company's downstream plants except in an emergency. In recent years, however, most water releases from the lake, including those from above the reserve level, have been made at times when the water could be used for both power generation and irrigation on farms served by organizations that have contracted with the power company. Thus flows originating above Bear Lake are now being controlled and utilized for both power and other purposes except for an average of about 69,000 acre-feet annually.1/ This amount includes water released from lake storage solely for power generation and infrequent uncontrolled spills from the lake or at Stewart Dam. Further development of this water for use either above or below Bear Lake would interfere with present power operations and would require compact amendment. The average of 69,000 acre-feet annually represents the limit to which new depletions above Bear Lake could exceed presently undeveloped compact allowances without interfering with present consumptive uses below the lake.

1/ All streamflow data in this report are based on actual flows for the 1926-65 period reduced to reflect water-consuming uses now made or definitely scheduled and all compact-permitted uses above Bear Lake.

Lifton Pumping Plant on north shore of Bear Lake. Mud Lake shows at right center.

Water Supply Below Bear Lake

Physically much of the average of 69,000 acre-feet annually that spills or is released from Bear Lake only for power could be controlled at the lake and released for multiple uses downstream. Releases of this water under the present compact operation are so sporadic, however, that the water could not be depended upon for further downstream uses and it is not included in present development plans.

Water that enters Bear River below Bear Lake and is not used consumptively offers the greatest potential for development. Since nearly all of this water is now used for power generation, further development would involve conversion to higher value uses under appropriate arrangements with the power company and the Federal Power Commission. No mainstem reservoirs have been constructed to control this water except forebay ponds at powerplants, and only limited storage capacity is provided for a few of the tributary streams. River inflows between Bear Lake and Corinne, Utah, near Great Salt Lake, exceed depletions in this section of the river by an average of 755,000 acre-feet annually. About 218,000 acre-feet of this water is usable within the seasonal pattern of need at the Bear River Migratory Bird Refuge below Corinne, leaving 537,000 acre-feet available for new water-consuming uses. Increased river diversions

accompanied by greater return flows from irrigation and other uses cannot be allowed to lower the quality of water remaining in the river below standards adopted by the basin States and approved by the Secretary of the Interior.

Reservoir Sites

Many reservoir sites exist on tributaries of Bear River. Future development of these sites, where practical, would not add significantly to full river regulation. Main-stem sites suitable for large developments above Bear Lake have not been investigated in detail by the Bureau of Reclamation because of storage limitations of the existing compact and because State and private interests have been active in the planning and construction of reservoirs in that area.

Few sites are available on Bear River below Bear Lake. The only such sites above Cache Valley are the Caribou site 2 miles south of Soda Springs, Idaho, and some alternative sites in Oneida Narrows Canyon, best of which is the Oneida Narrows site 10 miles northeast of Preston, Idaho. Cache Valley storage potentials include the Smithfield site near the center of the valley and an enlargement of the Cutler Reservoir formed by a dam at the valley outlet. In the Lower Bear River Valley are the Honeyville site near Honeyville, Utah, and the Corinne site near the mouth of the river which would require a 10-mile-long dike. On the Malad River is the Plymouth site near Plymouth, Utah. A reservoir at the Plymouth site could store Bear River water conveyed by a canal heading at or near Cutler Dam. All of these sites merit consideration in the planning of river developments. The selection of sites for initial development and the adoption of storage capacities may tend to define the character and scope of water and related resource developments over the foreseeable future.

Ground Water

Ground water underlies all of the valleys of the Bear River Basin. It is an important part of the total water supply in some localities. Reconnaissance ground water investigations in varying degree of detail have been completed or are now in progress in nearly all valleys of the basin. Ground water and surface water are so interrelated that development and use of one as a rule affects the supply of the other. Greater utilization of ground water and of natural underground storage reservoirs may be anticipated as more information is obtained about these potentials. This will not obviate the need for surface water development.

Potential Projects

In its cooperative work extending over a number of years, the Bureau of Reclamation has made many studies of development possibilities in

inventory, reconnaissance, or feasibility scope. Seven potentialities for water resource developments in the Bear River Basin, referred to as segments, are described in this report. Included in the discussion are three alternative plans for one of the segments and two for another. The plans are presented as being illustrative of the more favorable known development potentialities in the various parts of the river basin. The projects described are not necessarily proposed as integral parts of a comprehensive basinwide development. A river basin development comprised of any practical combination of the plans discussed would not provide complete control and utilization of the available resources. These plans could be added upon as further water conservation is justified. All plans are based on continued administration of Bear River and its tributaries in accordance with the Bear River Compact and State water laws. The scope and character of future water resource developments on Bear River will depend on water division agreements yet to be made by the basin States.

In plan appraisals benefit-cost ratios were taken as a measure of economic justification. The appraisals, made under current Federal criteria, are conservative. They reflect the high construction and interest costs of 1969 but benefits evaluated under methods adopted many years ago. Recognizing an imbalance in present criteria, the Water Resources Council is seeking a more realistic approach in economic appraisals. Thus appraisals made under future criteria may differ from those made now.

Costs of construction, operation, and maintenance would be allocated to the various purposes served by each segment as a basis for determining payment obligations. The farmers would need assistance in the repayment of construction costs allocated to irrigation. The sources of assistance would need to be determined in the course of detailed planning of any development. The Columbia River Basin Account and the Upper Colorado River Basin Fund would be explored as possible sources of financial assistance.

Thomas Fork-Smiths Fork Segment

A dam and reservoir would be constructed on Thomas Fork as the only facilities required for the Thomas Fork-Smiths Fork Segment. The dam site is in Wyoming about 4 miles upstream from the point where Thomas Fork enters Idaho. Stored water would be released in the late irrigation season. Part of it, to the extent of Idaho's compact allotment, would be used as a supplemental supply on lands along Thomas Fork in Idaho. The remaining water would flow on to Bear River, replacing an equivalent amount that would be diverted higher on the river or from Smiths Fork, a Bear River tributary, for supplemental irrigation in Wyoming. The segment would provide an average of 3,700 acre-feet of water annually that could be used within an area of 21,700 acres, including 8,100 acres in Idaho and 13,600 in Wyoming. The reservoir would provide benefits to fish and wildlife, recreation, and flood control.

The Thomas Fork-Smiths Fork Segment, highest in elevation of the seven segments, would be faced with a problem of a short growing season

and consequently a relatively low value for irrigation water. Under the present analyses the irrigators could pay operation, maintenance, and replacement costs but little on construction costs. Under future economic conditions or higher value water uses, this plan or a modified plan may be justified as a means of utilizing the water above Bear Lake allocated to Wyoming and Idaho. In the consideration of alternative plans that would develop water for Wyoming, two reservoir sites on Smiths Fork tributaries, Muddy Creek and Spring Creek, are among those that merit investigation.

Bennington Segment

The Bennington Segment would involve pumping of 14,200 acre-feet of water annually from Bear River for irrigation of 6,227 acres of land on the east side of the river near Bennington and Georgetown, Idaho. The pump lift would be 204 feet. Storage would be required in order to replace to downstream water users the water that would be pumped from the river. The storage could be provided at least cost in the potential Oneida Narrows Reservoir.

Project studies indicate that payment of operation and maintenance costs, including pumping costs, would utilize the full payment capacity of the irrigators. As an alternative to the Bennington Segment, potential reservoir developments on Bear River tributaries on both the east and west sides of Bear River Valley have been investigated as a means of providing irrigation water to valley lands. The steepness of the tributary canyons makes storage costs high for the limited water supplies available from these streams.

Caribou Segment

The Caribou Segment would consist of the Caribou Dam and Reservoir on Bear River near Soda Springs, Idaho. About 25,000 acre-feet of the reservoir water could be released to supplement the irrigation supply of the Last Chance Irrigation Company in the vicinity of Grace, Idaho. The remaining 10,000 acre-feet could be made available in the river or the reservoir for municipal and industrial needs anticipated in connection with an expanding phosphate-processing industry in the vicinity of Soda Springs. The reservoir would provide recreation and fish and wildlife benefits.

The Caribou Segment would be economically favorable when analyzed as a separate development. Revenues from outside sources would be required to repay somewhat more than half of the construction costs allocated to irrigation. The water that would be provided by the Caribou Reservoir could also be made available by exchange from the large Oneida Narrows Reservoir that would be a part of Oneida Narrows Segment Plans 1 and 2.

Oneida Narrows Segment

Three alternative plans for the Oneida Narrows Segment, each including an Oneida Narrows Reservoir on Bear River, have been studied. Similar project service would be provided under each plan.

In the first plan a large reservoir with 435,000 acre-feet of capacity would be constructed with the stored water distributed by gravity flow through a potential 75-mile-long Oneida Canal and other canals for irrigation and other purposes in Cache, Malad, and Lower Bear River Valleys. Water needs above the reservoir for irrigation in Gem Valley, Idaho, and municipal use in the Soda Springs-Montpelier area could be served by exchange. The second plan is similar to the first except that water distribution below Oneida Narrows would be made by a number of short canals and pumping plants instead of by gravity flow through a long Oneida Canal. In the third plan a smaller Oneida Narrows Reservoir with a capacity of 140,000 acre-feet would be supplemented by reservoirs at the Caribou and Smithfield sites, with appropriate changes in distribution facilities. The Caribou Reservoir would have a capacity of 40,000 acre-feet and the Smithfield Reservoir 70,000 acre-feet.

All plans would provide water for fish and wildlife uses, including maintenance of minimum pools in some existing reservoirs in Cache Valley and a supply for a potential Coulam National Wildlife Refuge near Oxford, Idaho. Project reservoirs would also provide other benefits to fish and wildlife, recreation, and flood control.

All of the Oneida Narrows Segment plans would have favorable benefit-cost ratios although the ratio for Plan 3 would be marginal. The irrigation water supply and acreage served would be slightly greater in Plan 1 than in the other plans. All plans would provide the same amount of water for municipal and industrial use and comparable benefits to recreation. Plans 1 and 2 would provide greater fish and wildlife and flood control benefits than Plan 3. Plan 1 would have the lowest costs for both construction and operation and maintenance. It would require the least assistance from outside sources in the repayment of costs allocated to irrigation.

Capacity could be added to the Oneida Narrows Reservoir to serve the Caribou Segment by exchange at a lower cost than that of the Caribou Reservoir.

East Cache Segment

The East Cache Segment would develop flows of Cub River, a Bear River tributary, for irrigation and municipal and industrial use in northeastern Cache Valley. The project would also provide flood control, recreation, and fish and wildlife benefits. Project works would consist of the Mapleton Dam and Reservoir on Cub River about 3 miles northeast of Franklin,

Idaho, and the East Cache Canal extending south 19 miles from the reservoir to Summit Creek near Smithfield, Utah. A total of 24,800 acres of land would receive irrigation water, and 1,000 acre-feet of water would be provided for municipal use in Smithfield and Lewiston, Utah.

The East Cache Segment would have a favorable benefit-cost ratio. The farmers could probably repay about 20 percent of the irrigation construction costs in a 50-year period with outside assistance required for the remainder.

Irrigating alfalfa near Richmond, Utah. Gilt Edge Flour Mill in background.

Blacksmith Fork Segment

Two alternative plans were studied for the Blacksmith Fork Segment in southeastern Cache Valley. A basic difference between the plans is that they involve different storage sites on Blacksmith Fork. The first plan includes a 10,000-acre-foot capacity reservoir at the Mill Creek site about 14 miles above the mouth of Blacksmith Fork Canyon. The second plan reservoir, with 47,000 acre-feet of capacity, would be at the Forks site 3 miles above the canyon mouth. Under either plan a Providence

Bench Canal would extend northward 10 miles from near the mouth of the canyon to Logan River. The canal would deliver 7,700 acre-feet of water annually to existing irrigation systems and 2,000 acre-feet for municipal and industrial use. An additional 25,000 acre-feet of water would be made available by the larger reservoir of Plan 2. This additional water could be released into Bear River as needed for downstream uses. If desired, the water could also be moved upstream on the river system by exchange. Benefits to fish and wildlife, recreation, and flood control would accrue from either plan.

Both plans for the Blacksmith Fork Segment could fill water needs that are expected to become greater as time goes on. Under either plan the irrigators could pay their allocated costs of operation and maintenance and one-fifth of the construction costs allocated to irrigation. A development made under future conditions or with modified appraisal criteria may well be justified.

Honeyville Segment

The 120,000-acre-foot capacity Honeyville Reservoir on Bear River would be the principal feature of the Honeyville Segment. An average of 68,000 acre-feet of water annually would be released from the reservoir for the Bear River Migratory Bird Refuge. A firm supply of 30,000 acre-feet annually would be available in the reservoir to meet anticipated requirements for municipal and industrial use in southern Box Elder County. The project would provide benefits to fish and wildlife and recreation and minor benefits to flood control.

Annual benefits of the Honeyville Segment would substantially exceed annual costs, showing that the project would be economically justified.

Summary data

Summary data on the segments are shown in the table on the following page.

Comparative summary data for potential segments

	Thomas Fork-Smiths Fork	Bennington	Caribou	Oneida Narrows Plan 1	Oneida Narrows Plan 2	Oneida Narrows Plan 3	East Cache	Blacksmith Fork Plan 1	Blacksmith Fork Plan 2	Honeyville
Irrigation service area (acres)										
Full service		4,972		39,400	37,400	38,000	3,900	1,125	7,325	
Supplemental service	21,700	1,255	28,000	49,200	48,100	49,200	20,900	875	875	
Total	21,700	6,227	28,000	88,600	85,500	87,200	24,800	2,000	8,200	
Water supply (acre-feet annually)										
Irrigation	3,700	14,200	25,000	177,200	169,500	171,200	22,600	7,700	32,700	
Municipal and industrial			10,000	20,000	20,000	20,000	1,000	2,000	2,000	30,000
Fish and wildlife	-			14,000	14,000	14,000				68,000
Total	3,700	14,200	35,000	211,200	203,500	205,200	23,600	9,700	34,700	98,000
Bear River depletion (acre-feet annually)										
Wyoming	1,350									
Idaho	500	6,700	22,500	82,500	77,000	75,000	4,200			
Utah				47,500	47,000	57,000	9,400	4,600	1/ 17,000	38,000
Total	1,850	6,700	22,500	130,000	124,000	132,000	13,600	4,600	17,000	38,000
Costs (dollars)										
Construction	4,446,000	5,883,000	9,175,000	80,092,000	80,877,000	102,497,000	16,563,000	7,962,000	29,737,000	11,641,000
Operation, maintenance, and replacement	8,000	28,500	7,600	185,000	256,000	328,000	28,000	14,500	31,000	72,900
Annual equivalent cost	224,000	313,000	453,000	4,269,000	4,398,000	5,561,000	837,000	398,500	1,477,000	639,000
Benefits (dollars annually)										
Irrigation	42,000	185,000	708,000	5,813,000	5,559,000	5,617,000	909,000	190,000	1,010,000	
Municipal and industrial			110,000	221,000	221,000	221,000	13,000	113,000	113,000	767,000
Fish and wildlife	18,000		20,000	254,000	254,000	191,000	27,000	27,000	75,000	221,000
Recreation	12,000		20,000	151,000	151,000	151,000	15,000	18,000	20,000	218,000
Flood control	26,000			62,000	62,000	30,000	21,000	3,000	8,000	4,000
Power and right-of-way losses	-2,000	-8,000	-56,000	-273,000	-259,000	-321,000	-18,000	-7,000	-14,000	-143,000
Total	96,000	177,000	802,000	6,228,000	5,988,000	5,889,000	967,000	344,000	1,212,000	1,067,000

1/ Entire depletion shown as occurring in Utah pending a determination of place of use of part of water.

CHAPTER II

DESCRIPTION OF BEAR RIVER BASIN

The River, Valleys, and Communities

Bear River is the Western Hemisphere's largest stream that does not reach the ocean. The river rises in Utah but flows through parts of Wyoming and Idaho before returning to Utah to empty into Great Salt Lake. In its circuitous course the river flows about 500 miles, but the airline distance from its source to its mouth is only 90 miles. The Bear River Basin comprises 7,465 square miles of mountain and valley lands, including 2,695 in Idaho, 3,270 in Utah, and 1,500 in Wyoming. The Bear River Basin and adjacent areas in Great Salt Lake Valley are shown on the frontispiece map.

For the first 20 miles of its course the river flows down the north slopes of the Uinta Mountains in Utah. Then, at the Wyoming boundary, it enters the first of a series of five major valleys that extend along the remainder of its course. The valleys are separated by narrow canyons or gorges, some of which contain hydroelectric power developments.

The highest and longest valley in the Bear River Basin is the Upper Bear River Valley. It extends about 100 miles roughly along Wyoming's western boundary but includes a substantial area in Utah and a lesser area in Idaho. The valley is narrow with its bottom lands 5 miles or less in width. Communities in the valley include Evanston and Cokeville, Wyo., and Randolph and Woodruff, Utah.

A few miles below its point of entry into Idaho, Bear River flows westward into Bear Lake Valley which is about 50 miles long and has a maximum width of 12 miles. The south end of this valley is mostly occupied by Bear Lake which is about 20 miles long and averages 7 miles in width. Mud Lake, about 3 miles in diameter, is at the north end of Bear Lake. The river does not flow naturally into these lakes, but in 1902 connecting inlet and outlet canals were constructed north of the lakes. In 1914 the Lifton Pumping Plant was constructed to pump from Bear Lake into the outlet canal. Bear and Mud Lakes, with a combined active storage capacity of 1,452,000 acre-feet, afford virtually complete control of Bear River flows at that location. Valley bottom lands north of Bear Lake are generally irrigated by diversions from Bear River while some of the arable bench lands on each side of the valley are irrigated from the many inflowing tributary streams. Among Idaho communities in Bear Lake Valley are Montpelier, St. Charles, Fish Haven, Bloomington, Paris, Liberty, Bennington, and Georgetown. Utah communities include Garden City and Laketown.

Leaving Bear Lake Valley at the north, the river flows through several miles of hilly and broken grazing lands and lava plains and thence through a deep, narrow channel cut through a lava sheet near Soda Springs, Idaho. In this channel are located the Soda Reservoir and hydroelectric powerplant. Below the powerplant Bear River enters a broad agricultural area known as Gem Valley. Anciently Bear River flowed northward through Gem Valley to the Snake River in the Columbia River Basin. A lava flow, however, turned the river south toward Great Salt Lake. The northern and central portions of Gem Valley consist of a plain formed by a lava flow and are occupied by large dry farms with some irrigation from Bear River and other inflowing streams. The southern part of Gem Valley, south of Grace, Idaho, and beyond the lava flow, is about 500 feet lower in elevation than the central portion. This lower portion is also known as Gentile Valley and the extreme southern portion as Mound Valley. The abrupt drop of Bear River into Gentile Valley is utilized for power generation at the Grace Powerplant. A further fall in the river immediately below the Grace Powerplant is utilized for power generation at the Cove Powerplant. Irrigation water sources in Gentile Valley are Bear River and tributary streams. Gem, Gentile, and Mound Valley communities include Grace, Thatcher, and Cleveland, Idaho.

At the south end of Mound Valley the river enters the Oneida Narrows, a canyon about 11 miles in length. Here the existing Oneida Reservoir and Powerplant are located and a potential is provided for the Oneida Narrows Storage Reservoir, prominently considered in further river development plans. Oneida Narrows is approximately the midpoint of the river in the sense that inflows above and below the narrows are approximately equal.

Below Oneida Narrows the river enters Cache Valley, one of the more highly developed valleys in the Bear River Basin. Cache Valley is about 45 miles long and 10 miles wide. Among its principal communities are Preston, Dayton, and Franklin, Idaho; and Lewiston, Richmond, Smithfield, Logan, Hyrum, and Wellsville, Utah. The river enters Cache Valley from the northeast, meanders sluggishly southward down the valley, and exits westward through a 2-mile-long gorge into Lower Bear River Valley which is a part of Great Salt Lake Valley. Several Bear River tributaries enter Cache Valley from the east and lesser streams from the west. Water of these streams is used for irrigation, particularly on the higher lands near the base of the mountains. In the gorge through which Bear River leaves Cache Valley are located the Cutler Dam and Powerplant which constitute the lowest hydroelectric development on the river.

Below Cutler Dam Bear River continues southwest through Lower Bear River Valley to the Bear River Bay of Great Salt Lake. The Bear River Migratory Bird Refuge is located at the river terminus. Utah communities in Lower Bear River Valley include Garland, Tremonton, Bear River City, and Corinne. The Malad River, flowing southward, enters Bear River about 10 miles north of Bear River Bay. The Malad River Valley extends northward 50 miles from Lower Bear River Valley. Its principal communities are Malad, Samaria, and St. John, Idaho; and Portage and Plymouth, Utah.

Lower Bear River Valley is the part of the relatively flat Great Salt Lake Valley that drains toward Bear River. West of Bear River in Great Salt Lake Valley are Blue Creek, Hansel, and Curlew Valleys that are outside of the Bear River drainage area but have been considered as within the area potentially serviceable from Bear River.

The locations of valleys and subvalleys in the Bear River Basin are shown by county and State in the listing below.

Valley	County and State
Upper Bear River	Summit and Rich, Utah Uinta and Lincoln, Wyo.
Bear Lake	Bear Lake, Idaho Rich, Utah
Gem	Caribou and Franklin, Idaho
Gentile	Caribou and Franklin, Idaho
Mound	Franklin, Idaho
Cache	Franklin and Bannock, Idaho Cache, Utah
Great Salt Lake	
Lower Bear River	Box Elder, Utah
Malad	Box Elder, Utah Oneida, Idaho Power, Idaho

Valley elevations range from 4,200 feet at Bear River Bay to 7,800 feet near Evanston, Wyo., in the Upper Bear River Valley.

Within recent geologic history, three large lakes were located in the present Bear River drainage area. They were (1) the ancestral Bear Lake which was much larger than the present lake, (2) Thatcher Lake which occupied the southern part of Gem Valley and the whole of Gentile and Mound Valleys, and (3) Lake Bonneville which covered the floor of Great Salt Lake and Cache Valleys. Remnants of Bear and Bonneville Lakes still exist. The lowering of their outlet channels by erosion has reduced the size of Bear Lake and eliminated Thatcher Lake. Lake Bonneville shrank below its outlet to the present Great Salt Lake when changes in climate reduced inflow to the lake to less than evaporation from the lake surface. The sediments deposited in these lakes and the subsequent erosion were primary factors in forming the present topographic features of the Bear River Basin.

Climate

The climate of the Bear River Basin is of typical mountain continental character with the usual wide range in temperature between summer and winter and between day and night. The high mountain valleys experience long and rigorous winters and short, cool summers. The lower valleys are

more moderate with less variance between the maximum and minimum temperatures. Precipitation is heaviest in the mountainous sections with much of it occurring during the winter months in the form of snow. Precipitation during the May through September growing season is only about one-third of the annual amount. The average frost-free season varies from about 30 days in some high mountain valleys to more than 150 days in the Great Salt Lake Valley. Climatological records at representative U.S. Weather Bureau stations throughout the basin are summarized below.

Weather records at representative stations in Bear River Basin

Weather station	Elevation above sea level (feet)	Precipitation: Average annual (inches)	Precipitation: Average May to September (inches)	Precipitation: Years of record	Temperature: Average annual (° F.)	Temperature: Maximum (° F.)	Temperature: Minimum (° F.)	Temperature: Years of record	Average frost-free period (days)
Wyoming									
Evanston	6,860	10.49	4.49	68	39.4	96	-38	67	43
Sage	6,320	9.27	4.39	40	38.7	104	-47	39	17
Border	6,120	13.02	5.01	66	38.2	102	-60	63	37
Idaho									
Lifton Pump	5,930	9.62	4.21	49	41.7	99	-40	49	117
Montpelier	5,960	13.67	5.34	51	41.7	102	-34	46	70
Grace	5,400	14.20	6.00	57	42.2	103	-40	55	98
Preston	4,720	15.49	5.60	46	46.3	105	-32	45	126
Malad	4,420	13.97	5.06	52	46.7	108	-25	49	131
Strevell	5,290	10.50	4.94	26	45.7	102	-16	24	93
Utah									
Woodruff	6,340	9.22	4.53	46	38.6	96	-50	45	38
Laketown	5,990	10.59	4.34	64	42.4	98	-37	67	64
Lewiston	4,480	17.66	5.83	43	45.8	105	-44	43	116
Richmond	4,650	18.37	5.74	57	47.6	104	-20	19	120
Logan Exp. Sta.	4,610	14.95	4.69	18	47.3	99	-20	17	130
Logan U. S. U.	4,790	16.64	5.14	73	48.8	102	-25	73	161
Hardware Ranch	5,580	14.45	4.56	13		96	-36	8	40
Tremonton (ends 1943)	4,320	13.82	4.80	28	48.9	106	-25	28	
Garland (begins 1943)	4,350	14.84	5.60	26	48.2	104	-21	26	147
Corinne	4,230	14.96	4.52	90	49.3	109	-32	69	141
Brigham	4,340	17.73	5.10	56	51.0	108	-27	50	164
Bear River Refuge	4,210	11.61	4.12	30	50.7	105	-26	28	173

Land Resources

Land use types

About 21 percent of the land area of the Bear River Basin has been inventoried as arable and 79 percent as nonarable. Arable land, by Bureau of Reclamation definition, has sufficient potential payment capacity to warrant consideration for irrigation development. All of the arable lands and a large portion of the nonarable lands have agricultural value in these categories: (1) farm lands located in the major valleys and along Bear River tributaries, (2) range or grazing lands in the hills and mountain areas and in the uncultivated valley areas, and (3) forest lands, usually comprising the higher mountain areas, which also provide some summer grazing for livestock. A minor portion of the nonarable land is unproductive agriculturally, being inundated by water or for other reasons having no useful vegetation. Acreages of each land type by counties are shown in the table on the following page.

Land inventory--Bear River Basin
(Unit--acres)

State and county	Arable land	Nonarable land			
		Grazing[1]	National forests	Nonagricultural lands and water areas	Total nonarable land
Utah					
Summit	4,000	17,100	164,800	1,600	183,500
Rich	119,500	468,200	51,800	50,400	570,400
Cache	172,300	306,400	268,900	5,000	580,300
Box Elder	158,800	185,200	23,500	94,700	303,400
Subtotal	454,600	976,900	509,000	151,700	1,637,600
Idaho					
Bear Lake	146,800	265,700	205,600	50,100	521,400
Caribou	69,500	121,400	30,800	6,600	158,800
Bannock	6,000	50,600	5,000	1,500	57,100
Franklin	112,700	192,800	113,500	7,500	313,800
Oneida	96,700	155,600	76,700	3,800	236,100
Power		5,500		400	5,900
Subtotal	431,700	791,600	431,600	69,900	1,293,100
Wyoming					
Uinta	59,300	251,600		9,500	261,100
Lincoln	72,200	383,100	172,800	10,700	566,600
Subtotal	131,500	634,700	172,800	20,200	827,700
Total	1,017,800	2,403,200	1,113,400	241,800	3,758,400

1/ Does not include grazing lands on National forests.

Arable lands outside the Bear River Basin that could be irrigated from Bear River lie west of the Lower Bear River Valley in parts of the Great Salt Lake Valley that are identified as Blue Creek, Hansel, and Curlew Valleys. The lands cover about 423,000 acres, including 230,500 acres in Box Elder County, Utah, and 192,500 acres in Oneida and Cassia Counties, Idaho. These lands are shown on the frontispiece map but are not included in acreage data applicable to the Bear River Basin.

Soil materials

Arable lands of the Bear River Basin have developed from three principal types of soil materials: lacustrine or lake deposited, loessial or wind deposited, and alluvial or stream deposited. Lacustrine sediments are the predominant source materials on the ancient Lake Bonneville floor, comprising valley lands in Franklin and Oneida Counties in Idaho and Cache and Box Elder Counties in Utah. Loessial deposits are the principal soil source in Caribou County, Idaho. Alluvial sediments occupy the flood plain, fan, and footslope areas in the upper valleys of the basin in Bear Lake County in Idaho, Lincoln and Uinta Counties in

Wyoming, and Rich County in Utah and are the principal materials from which soils in these areas have developed.

Potato field near Preston, Idaho.

Quartzites and sandstones predominate as source materials for soils in the upper valleys in the Bear River Basin. Limestones, dolomites, and sandstone are the most prominent source materials for soils in the central valleys, while tuffaceous sediments, limestones, shales, and basalts are the principal source materials for soils of the Malad River and northern Great Salt Lake Valleys.

Arable lands in valleys above Bear Lake principally occupy flood plains of the valley floors. Being so near the parent material source, valley-fill sediments in these areas consist mainly of coarse sands and gravels which settled out first from conveying waters. In many of the upper valley areas, however, soil development processes and the addition of loessial materials have left medium- to fine-textured topsoils and subsoils overlying the coarse sands and gravels.

A minor part of the arable land area in the upper valleys is located on fans, foot slopes, and tributary stream alluvium at the perimeter of

the valley floors. Most of these lands are on alluvial and alluvial-colluvial sediments, but some are on loessial deposits. Soils in the valley perimeter areas are primarily medium- to moderately fine-textured but some are sandy and sandy-gravelly.

Arable lands in the area below Bear Lake and above Soda Springs, Idaho, occupy recent outwash fans, foot slopes, and river alluvium to a greater extent than do upper valley lands. A considerable part of the land below Bear Lake is on early valley-fill sediments. Soils on the valley floor are primarily of alluvial-lacustrine origin and are finer textured than the soils at higher elevations near the rim of the valley. Soils vary from loams to clays, with the clays largely confined to the lower part of the valley floor. The recent outwash materials range from loams to heavy silty clay loams and contain considerable quantities of sand and cobble. Predominant textures are gravelly silt loams and silty clay loams.

Arable lands in the Bear River Basin between Soda Springs and Thatcher, Idaho, have developed principally from wind-deposited materials. The soils overlie fractured, interbedded basalt flows, usually at a depth of 5 to 15 feet. The soils range from loams to clay loams with silt loams and clay loams predominating. The minor soil areas on recent outwash fans and stream deposits near the basin perimeter are medium to moderately fine in texture.

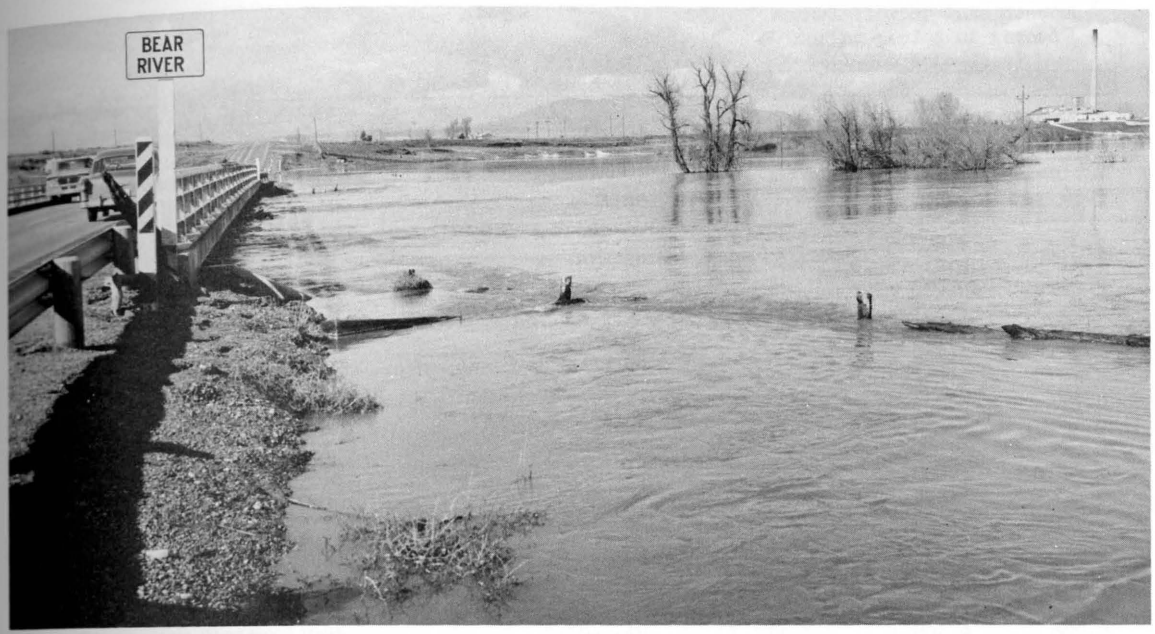
Arable lands in Cache, Lower Bear River, and Malad Valleys have developed primarily on Lake Bonneville sediments. The prominent shoreline benches carved by the fluctuating water levels of Lake Bonneville have been eroded by sediment-laden inflowing streams. These streams caused a buildup of extensive deltas, benches, and bars at the perimeter of the valleys and a sorting of lacustrine sediments on the valley floors. The soils of this area range from sandy loams to clays, with loams, silt loams, clay loams, and clays predominating. Clays are extensive in the lower segments of the valley floors.

Water Resources

Surface water

Bear River and its principal tributaries originate in mountain areas where precipitation is heavy. Typical of western streams, flows vary widely from season to season and from year to year. About 60 percent of the annual flow usually occurs during the snowmelt period in April, May, and June. Annual flows of the larger tributaries range from 40 percent of normal in extremely dry years to 175 percent in years of unusually heavy precipitation. Flows of smaller tributaries are even more variable. Infrequently the high spring flows cause flood damage, mostly from inundation of farm land and sediment depositions. Heavy summer and fall rains

occasionally cause the smaller streams to rise to high stages but rarely have much effect on the main river.



Bear River at flood stage, February 1962. Looking west from bridge at Amalga, Utah.

Streamflow records on Bear River are of relatively long duration, some extending back to 1889. The river gaging stations above Bear Lake and most of the tributary stations in the entire river basin are operated by the Geological Survey. Most of the main river stations below Bear Lake are operated by the Utah Power & Light Company under direction of the Federal Power Commission in cooperation with the Geological Survey. Locations of key gaging stations on the river and its tributaries are shown on the frontispiece map. Water Commissioners' reports provide an additional source of information. Among the most useful are reports for Idaho District No. 5, Little Bear River, and Logan River.

Streamflow and diversion records at key stations in the Bear River Basin are tabulated on the following page.

Ground water

Ground water in varying amounts underlies all of the valleys of the Bear River Basin. The water occupies alluvial sand and gravel aquifers and fractured cavernous basalt aquifers within valley fills. Ground water is deposited through percolation from overlying lands and by seepage from stream channels, particularly in porous areas on the rim of the valley floors near the mouths of canyons. Ground water and surface water

Streamflows and diversions at key stations

Gage location	Period of record	Annual flow or lake content during period of record (1,000 acre-feet) Average	Maximum	Minimum
Bear River flows and lake content				
Bear River near Utah-Wyoming State line	1942-68	135.4	206.8	79.3
Bear River near Evanston, Wyo.	1913-56	169.4	305.2	36.8
Bear River above reservoir near Woodruff, Utah	1961-68	173.8	283.2	85.5
Bear River below reservoir Woodruff, Utah	1961-68	167.2	252.6	80.4
Bear River near Randolph, Utah	1943-68	136.1	314.2	16.5
Bear River at Border, Wyo.	1937-68	288.1	535.7	79.3
Bear River at Harer, Idaho	1913-68	367.1	724.1	78.0
Rainbow and Dingle inlet canals near Dingle, Idaho	1914-68	231.3	556.6	36.8
Bear River below Stewart Dam near Montpelier, Idaho	1916-68	51.2	442.8	1.9
Bear Lake active content[1/]	1909-68	884.8	1,423.0	0
Bear Lake outlet canal near Paris, Idaho	1913-68	250.3	668.4	81.2
Bear River at Pescadero, Idaho	1913-54	448.2	936.3	192.9
Bear River at Alexander, Idaho	1911-68	542.3	1,090.7	273.7
Bear River below powerplant tailrace at Oneida, Idaho	1913-68	608.5	1,194.6	297.9
Bear River near Preston, Idaho	1943-68	570.5	1,091.0	364.4
Bear River near Collinston, Utah	1889-1968	1,118.7	2,598.3	319.9
Bear River near Corinne, Utah	2/1949-68	1,174.0	1,802.9	609.8
Bear River diversions				
Last Chance Canal system near Grace, Idaho	1914-68	99.1	141.1	62.4
Gentile Valley Canal	1920-68	15.0	19.2	7.3
West Cache Canal and four small adjacent canals	1920-68	43.2	63.7	27.8
Cub River pumps	1923-68	11.5	19.3	5.4
Westside Canal near Collinston, Utah	1912-68	171.6	219.3	113.2
Hammond (Eastside) Canal near Collinston, Utah	1912-68	36.8	46.8	16.3
Bear River tributary flows				
Smiths Fork near Border, Wyo.	1942-68	139.0	190.5	73.1
Thomas Fork Near Wyoming-Idaho State line	1949-68	37.5	66.0	10.4
Montpelier Creek near irrigators' weir	1942-68	15.5	28.8	5.3
Cottonwood Creek near Cleveland, Idaho	1938-68	21.1	38.3	7.0
Mink Creek near Mink Creek, Idaho	1943-52	37.6	51.7	20.9
Cub River near Preston, Idaho	3/1940-68	59.7	84.5	35.3
Logan River above State Dam near Logan, Utah	1896-1968	197.6	374.0	91.0
Blacksmith Fork above power company dam near Hyrum, Utah	1913-68	89.8	154.0	38.3
Little Bear River near Paradise, Utah	1937-68	60.7	100.2	25.6
Malad River at Woodruff, Idaho	1938-68	42.4	63.9	20.2

1/ Measured at Lifton Pumping Plant.
2/ Records not available in 1958-62, inclusive.
3/ Records not available in 1953 and 1954.

have a common basic source, and often the development and use of one may affect the supply of the other. Present ground water development and future potentials are discussed in Chapter III.

Water quality

Most of the surface and ground water of the Bear River Basin is of good quality and is suitable for the uses made of it with little or no treatment. The trend is for the quality to deteriorate somewhat as the water moves downstream. This is caused by return flows from irrigated lands and in some instances by industrial wastes and sewage. The Cache Valley portion of Bear River generally contains considerable sediment from unstable stream channels. Most of the sediment is so fine that it remains in suspension and passes through the Cutler Reservoir at the valley outlet. In Great Salt Lake Valley both the Bear and Malad Rivers receive water from mineral springs and drain areas where the soils are high in soluble salts. Water in the lower portion of the Malad River is so mineralized that it is unsuitable for most uses unless diluted.

Mineral Resources

Phosphate rock is the most important mineral resource in the Bear River Basin. About 56 percent of the Nation's phosphate reserves are estimated to be in the western phosphate field, much of which is in the Bear River Basin, primarily in Bear Lake and Caribou Counties, Idaho; Lincoln County, Wyo.; and Rich County, Utah.

Great Salt Lake at the terminus of Bear River is rich in magnesium and other valuable minerals. At today's national consumption rates the lake is estimated to contain a 2,000-year supply of magnesium, potash, lithium, and other minerals.

Located throughout the basin are deposits of clay, sand, gravel, limestone, and other materials used for building. These are being utilized primarily for local needs. Other minerals present in smaller amounts include copper, lead, gold, zinc, vanadium, manganese, and antimony. The basin contains unimportant deposits of oil, gas, and oil shale.

Recreation, Fish, and Wildlife Resources

The Bear River Basin with its mountains, high valleys, deep canyons, and clear streams and lakes, together with its relatively cool weather, is unusually attractive for outdoor recreation in the summer season. It also has a potential for winter sports but so far development in this field is aimed only at satisfying local needs.

Bear Lake with its deep blue water is the principal recreational attraction. Some of the Lake's attractiveness is lost in occasional prolonged drouth periods when the water is drawn down for power and irrigation uses. Smaller lakes and reservoirs throughout the basin are also used extensively for recreation.

The several scenic canyons in the basin through which flow clear mountain streams vie with the lakes in their recreational attractiveness. Logan Canyon is outstanding because of its scenery and good stream fishing.

Visitors to Cache Valley are generally impressed with its beauty. The scenery in Cache and other valleys in the basin is especially attractive during the verdant spring and color-drenched autumn months.

Mountain areas provide summer camping sites and big game hunting in the fall. Large numbers of deer and elk are harvested each year along with a few moose and bobcats. Beaver and muskrats are the principal furbearing animals.

Upland game birds include pheasant, chukar and Hungarian partridge, sage hens, and various species of grouse. Waterfowl are numerous on the lakes, reservoirs, streams, and marshes.

Principal game fish found in the mountain streams, lakes, and reservoirs are trout, whitefish, bass, walleye, and the unique Bonneville cisco that are native to Bear Lake.

CHAPTER III

DEVELOPMENT OF THE BASIN

Population

About 78,000 people resided in the Bear River Basin in 1960, according to the census for that year. About 60 percent of these people lived in Utah, 30 percent in Idaho, and 10 percent in Wyoming. Estimates of future county populations were made by the University of Utah for the Utah portion, Idaho State University for the Idaho portion, and the Bureau of Reclamation for the Wyoming portion. For counties only partially within the Bear River Basin the Bureau estimated the portion of populations within the basin. The actual annual growth rate averaged less than 0.5 percent from 1920 to 1960 whereas the projected annual growth rate beyond 1960 averages almost 2 percent. The greater increase in the future is based on the assumption that adequate water supplies will be available for municipal, industrial, and other purposes at reasonable cost and in anticipation of a substantial increase in phosphate production. Past and projected populations for the basin are shown in the following table.

Population of Bear River Basin[1/]

State and county	Actual			Projected			
	1920	1940	1960	1970	1980	1990	2000
Utah							
Cache	26,992	29,797	35,788	45,100	55,000	60,000	65,000
Box Elder	2/10,500	9,939	9,892	11,350	12,430	14,450	15,980
Rich	1,890	2,028	1,685	1,500	1,700	1,700	1,700
Subtotal	39,382	41,764	47,365	57,950	69,130	76,150	82,680
Idaho							
Bear Lake	8,783	7,911	7,148	7,500	8,510	9,490	10,590
Caribou	1,950	1,980	3/4,780	8,060	10,910	14,370	17,000
Franklin	8,650	10,229	8,457	9,140	9,390	9,450	9,600
Oneida	5,956	4,952	3,338	3,390	3,350	3,180	3,000
Subtotal	25,339	25,072	23,723	28,090	32,160	36,490	40,190
Wyoming							
Lincoln	2,430	1,635	1,390	1,500	1,620	1,730	1,850
Uinta	2,390	4,843	5,526	5,800	6,050	6,290	6,550
Subtotal	4,820	6,478	6,916	7,300	7,670	8,020	8,400
Total	69,541	73,314	78,004	93,340	108,960	120,660	131,270

1/ No populations are included for the small portions of Summit County, Utah, and Bannock and Power Counties, Idaho, that are in the basin.

2/ Estimated.

3/ Pronounced increase between 1940 and 1960 resulted from a change in county boundaries.

Populations of various cities and towns in the basin area for the 1920-60 period are shown in the table on the following page. Populations

of several of the smaller communities are noted to have decreased over this period, whereas populations of most of the larger cities have increased.

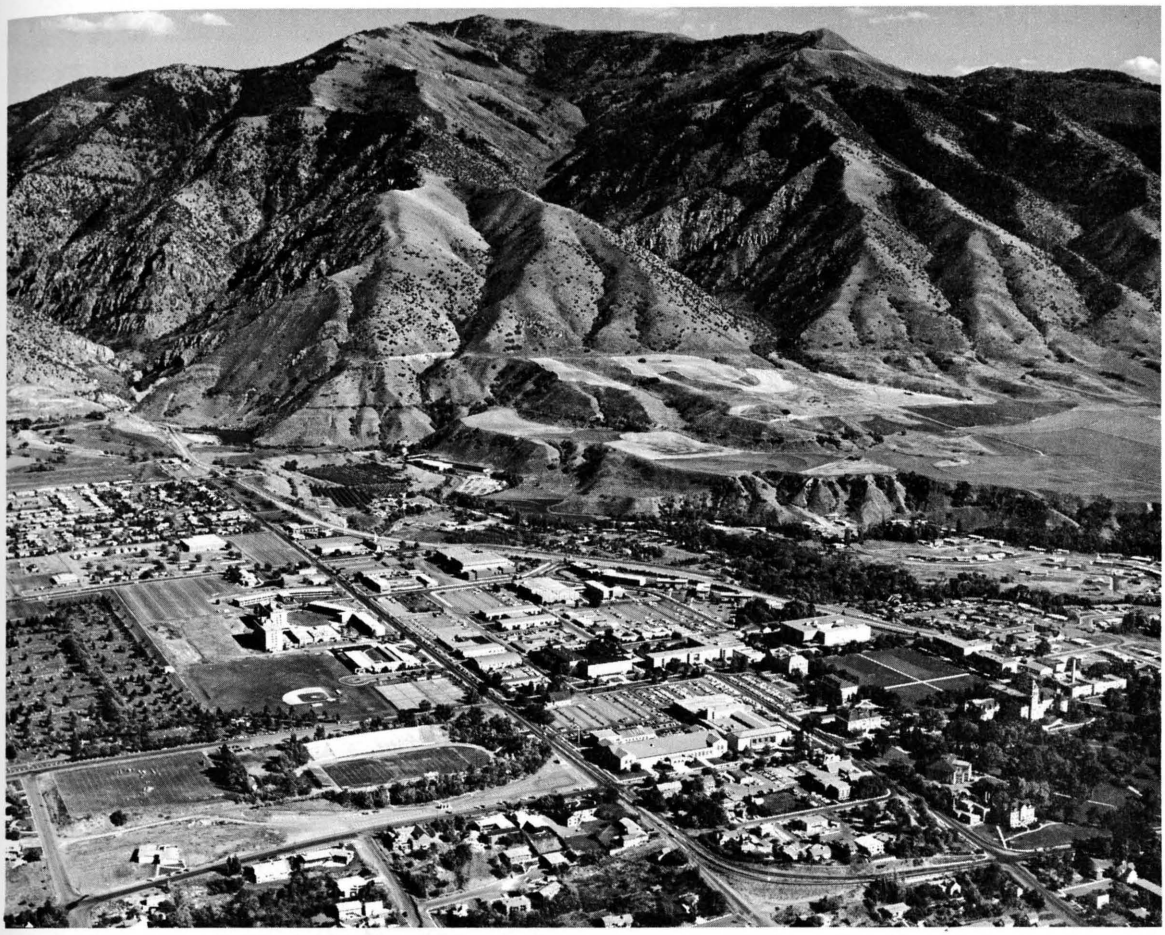
Population of communities in Bear River Basin

Community	1920	1930	1940	1950	1960
Utah					
Clarkston	635	687	634	567	490
Lewiston	1,302	1,783	1,835	1,533	1,336
Logan	9,439	9,979	11,868	16,832	18,731
Newton	687	NA	812	535	480
Richmond	1,396	1,310	1,280	1,206	977
Smithfield	2,708	2,446	2,559	2,475	2,512
Garland	999	824	926	1,001	1,119
Tremonton	937	1,009	1,443	1,662	2,115
Randolph	586	447	656	562	537
Idaho					
Georgetown	456	391	463	404	551
Montpelier	2,984	2,436	2,824	2,682	3,146
Paris	NA	825	932	774	746
Grace	1,509	1,479	1,459	1,663	1,932
Soda Springs	935	831	1,087	1,462	2,848
Clifton	463	509	532	404	150
Dayton	425	721	774	689	212
Weston	790	878	826	706	284
Fairview	445	500	567	469	NA
Franklin	589	531	523	467	446
Preston	3,235	3,381	4,236	4,045	3,640
Malad	2,598	2,535	2,731	2,714	2,274
Wyoming					
Cokeville	430	431	452	440	545
Evanston	3,226	3,075	3,605	3,863	4,901

NA--Data not available.

Social Development

The Bear River Basin is generally well served with transportation, communication, and electric services. Nearly all of the communities have municipal water systems, churches, and schools. Cultural attainments are high even though the per capita income is substantially below the national average. For years the basin area has ranked high in the level of formal education attained by its people. The trend is toward higher levels. The average period of school completion in Box Elder County where records are available increased from 9.8 years to 12.3 years between 1940 and 1960. This increase is believed to be representative of the basin area. The Utah State University, with a current enrollment of about 8,500 students, is within the basin at Logan, Utah.



Campus of Utah State University, Logan, Utah. Mouth of Logan Canyon at upper left.

Economic Development

Agriculture is the principal industry in the Bear River Basin. Beef cattle and sheep production and dairying are the largest sources of farm income. The processing of agricultural products is also widespread. Manufacturing, starting from a small base, has had a relatively large growth in the past 20 to 30 years while there has been no substantial agricultural expansion. The lack of agricultural growth, together with the trend toward farm mechanization and larger farm units, has caused a substantial decline in farm population and employment, reflected in the decreasing population of many of the small rural communities.

Agriculture and manufacturing combined accounted for 38 percent of the area's employment in 1960, with the remainder being accounted for in such diverse fields as services, trade, transportation, and education.

Basinwide employment by selected industries in the past three decades is shown below.

Employment in selected industries--Bear River Basin

Industry	1940 Number	1940 Percent of total	1950 Number	1950 Percent of total	1960 Number	1960 Percent of total
Agriculture	8,636	46.5	8,490	36.0	5,564	20.0
Mining	65	.5	84	.5	165	1.0
Manufacturing	1,106	6.0	1,485	6.5	4,978	18.0
Military	0	0	39	0	38	0
Other	8,654	47.0	13,235	57.0	16,706	61.0
Total	18,461	100.0	23,333	100.0	27,451	100.0

Economic development in the Bear River Basin has not been sufficient to absorb the increase in population resulting from the prevailing high birth rate. This has led to relatively low average incomes and the exodus of many people, particularly the youth, to seek employment opportunities elsewhere.

Farming

Arable Land Use

Arable lands in the basin are either irrigated, dry farmed, or used for livestock grazing. The extent of each use is shown by counties in the following table.

Present use of arable land--Bear River Basin
(Unit--acres)

State and county	Irrigated	Dry farmed	Grazed	Total
Utah				
Summit	200		3,800	4,000
Rich	55,600	9,200	54,700	119,500
Cache	85,600	70,900	15,800	172,300
Box Elder	66,200	32,200	60,400	158,800
Subtotal	207,600	112,300	134,700	454,600
Idaho				
Bear Lake	92,000	48,100	6,700	146,800
Caribou	38,400	30,200	900	69,500
Bannock	1,200	2,600	2,200	6,000
Franklin	54,400	57,100	1,200	112,700
Oneida	24,100	35,200	37,400	96,700
Subtotal	210,100	173,200	48,400	431,700
Wyoming				
Uinta	36,800		22,500	59,300
Lincoln	28,500	8,500	35,200	72,200
Subtotal	65,300	8,500	57,700	131,500
Total	483,000	294,000	240,800	1,017,800

Number, Type, and Size of Farms

Farming in the upper valleys of the Bear River Basin is largely restricted by climate to livestock raising and dairying. Crops in these valleys consist of meadow hay, irrigated pasture, alfalfa, and small grains. In the lower valleys farming is diversified and crops include wheat, barley, alfalfa, improved pasture, silage corn, sugar beets, peas, corn, green beans, tomatoes, potatoes, cabbage, stone fruits, berries, and apples.

The numbers of farms of various types in the Bear River Basin, as determined by the Census of Agriculture, 1964, are shown in the table below. The farms were classified according to their major source of income. Census farm counts for counties not wholly within the Bear River Basin were reduced by appropriate percentages. Nearly half of the farms are grouped into a general category designated as "other." These include general, poultry, vegetable, fruit, and miscellaneous farms. Many farms that are classed as dairy or crop farms also include a small livestock unit.

Number and type of farms

State and county	Percent of county in study area	Number of farms				
		Field crop[1]	Livestock and livestock products[2]	Dairy	Other	Total
Utah						
Cache	100	174	152	521	806	1,653
Box Elder	11	27	27	20	68	142
Rich	100	2	122	11	69	204
Idaho						
Franklin	100	123	70	297	306	796
Oneida	48	54	35	9	65	163
Bear Lake	100	55	146	90	225	516
Caribou	3/75	149	75	37	99	360
Wyoming						
Lincoln	45	8	65	87	77	237
Uinta	35	0	65	6	21	92
Total		592	757	1,078	1,736	4,163
Percent of farms		14.2	18.2	25.9	41.7	100

1/ Excludes vegetable and fruit farms.
2/ Excludes dairy and poultry farms.
3/ Figures include 75 percent of census farm count for Caribou County plus minor additions for farms in the small parts of Bannock and Power Counties, Idaho, within the basin.

The 4,163 basin farms classified in the 1964 census had an average size of 1,295 acres. Farms in Box Elder, Caribou, and Lincoln Counties

were near the basin average in size; those in Rich and Uinta Counties were much larger; and those in Cache, Franklin, Oneida, and Bear Lake Counties were smaller than average. Approximately 60 percent of the basin farms were less than 220 acres in size and 24 percent were less than 50 acres. The large farms are mostly devoted to livestock or dry farm operations, while the smaller farms as a rule are part-time or general crop operations.

Aerial view of Malad, Idaho, looking north.

Crop production is generally dependent on irrigation but dry farming with lower yields per acre is also practiced in areas where rainfall and soil conditions are favorable. Dry farming is most profitable on large farms.

Livestock raising is an important enterprise in every part of the Bear River Basin area but is relatively most important in the higher valleys. Regulated summer grazing on national forest and other public lands serves to supplement feeds grown on privately owned lands. More than 200,000 beef cattle and calves were in the area, according to the 1964 Census of Agriculture. There were also 264,000 sheep, 277,000 chickens, and 17,800 pigs.

Dairying is the major source of income on only 25.9 percent of the area's farms, although about 80 percent of the irrigated farms in the

lower valleys have some milk cows. An average herd on dairy farms includes about 25 cows. Approximately 36,000 head of dairy cattle are in the Bear River Basin. Valleys of the river basin are unusually well suited for dairying. Herds have been improved through careful selection and breeding to the point that their quality is unusually high.

The 1964 agricultural census showed that the eight major crops grown on irrigated land in the basin occupied about 60 percent of the irrigated area. The area devoted to each crop, expressed both in acres and percentage of the whole, is shown below.

Acreages of major crops--Bear River Basin

Crop	Acres	Percent of total acreage
Alfalfa	98,981	20.5
Spring wheat	15,804	3.3
Winter wheat	12,633	2.6
Barley	44,557	9.2
Silage corn	9,327	1.9
Sugar beets	18,893	3.9
Potatoes	3,006	.6
Wild hay	89,289	18.6
Other crops	190,510	39.4
Total	483,000	100.0

Crop yields per acre vary from county to county and as a rule are highest in the lower areas. An exception is Caribou County, in the middle elevation range, where reported yields of winter wheat and potatoes were the highest in the basin.

Farm Income

Products sold from basin farms in census year 1964 were valued at $53 million or an average of $12,700 per farm. These values are an approximate measure of gross farm income. Nearly 40 percent of the basin's farm income went to livestock farmers and averaged $23,200 per farm. One-third went to field crop farmers and averaged $25,900 per farm. Dairy farms produced 22 percent of the farm income with an average income of $11,300 per farm, while 5.5 percent of the farm income was derived from other farms where the average was only $1,040 per farm.

Farm Values

The value of lands, buildings, machinery and other equipment averaged $58,200 per farm in the Bear River Basin, according to the Agricultural Census of 1964. The values ranged from about $52,000 per farm in Cache and Bear Lake Counties to $119,000 in Caribou County. Farm values per acre averaged $84 and ranged from $27 in Uinta County to $188 in

Cache County. Values per acre are highest in the more intensively farmed areas and lowest in the upper valleys.

Industry and transportation

The processing of agricultural products is the most important type of manufacturing in the Bear River Basin. Beet sugar factories, cheese and other dairy food plants, vegetable packing plants, meat packing plants, and flour mills comprise the principal food processing enterprises. These plants, located in the lower valleys of the basin, employ about 1,800 people. A small sawmill was recently established in Cache Valley.

Phosphate plant of Monsanto Company near Soda Springs, Idaho.

Five large firms are either engaged in the mining and processing of phosphate rock or have acquired property for future development. These are Monsanto Company, El Paso Natural Gas Products Company, J. R. Simplot Company, San Francisco Chemical Company, and Mountain Fuel Supply Company. A number of large chemical companies have shown active interest in the extraction of magnesium and other minerals from the brines of Great Salt Lake and several have obtained land around the lake. The Great

Salt Lake Minerals and Chemical Corporation's Little Mountain facility is now under construction near the lakeshore and is scheduled to begin operations by late 1970. The National Lead Company has a plant under construction near Tooele, Utah. The Thiokol Chemical Corporation produces rocket propellant units for the Federal Government at its plant just outside the Bear River Basin in Box Elder County and conducts research and development work under contract. A number of other small manufacturing plants have been established in recent years, mostly near Logan, Utah. Their products include over-snow vehicles, business forms, farm equipment, missile and satellite components, and wearing apparel.

The basin enjoys excellent transportation facilities. Two different main line sections and a branch of the Union Pacific Railroad serve the various valleys within the basin. U.S. Highways 30N, 30S, 89, 91, and 191 and Interstate Highways 80N and 15 traverse parts of the basin. Numerous other roads extend from these main arteries to all developed sections. Motor transport and bus lines operate in the basin.

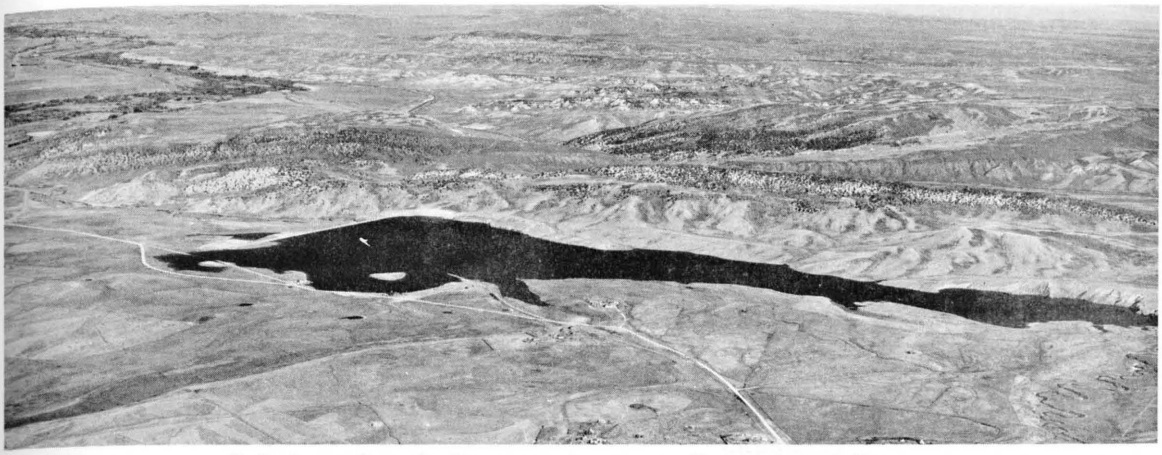
Surfaced and lighted airstrips adequate for prop aircraft are maintained at Evanston, Wyo.; Montpelier, Soda Springs, Preston, and Malad, Idaho; and Logan, Tremonton, and Brigham City, Utah. At present there is no scheduled air service into the basin.

Water Resource Development

Main stem flows of Bear River are used principally for irrigation and hydroelectric power production. Part of the water which reaches the mouth of the river is used in waterfowl refuges and the remainder discharges into Great Salt Lake. Flows of tributary streams are used mainly for irrigation with some developments for hydroelectric power and municipal and industrial purposes. Ground water from numerous wells is used for domestic, stockwatering, irrigation, municipal and industrial purposes. Water rights have been established and are administered in accordance with the laws of the three States of the river basin. The river is operated under the terms of the tri-State Bear River Compact which is further discussed in Chapter IV.

Storage reservoirs

Flows of Bear River not required for downstream irrigation or power rights are diverted into Bear Lake and Mud Lake for storage regulation. The large lake capacity affords almost complete control of the river at that location. The Utah Power & Light Company operates storage at these lakes for power production at its five hydroelectric powerplants on Bear River and for irrigation.



Sulphur Creek Reservoir near Evanston, Wyo.

Hyrum Dam and Reservoir on Little Bear River near Hyrum, Utah.

Approximately 1,421,000 acre-feet of Bear Lake storage capacity is within the limits of gravity releases and pump drawdown. An additional 31,000 acre-feet of active capacity is provided at Mud Lake.

Reservoir storage capacity for water tributary to Bear River below Bear Lake is far less than required for river control. Consequently a large portion of the water entering this section of the river is unused except for hydroelectric power production. Forebay reservoirs at powerplants regulate hourly and daily fluctuations in streamflow and permit changes in power generation to meet load variations. The forebay reservoirs have active capacities as shown below.

	Active capacity (acre-feet)
Soda	10,000
Grace	1/
Cove	1/
Oneida	11,000
Cutler	16,000

1/ Less than 500 acre-feet.

Excluding the forebay impoundments, 25 reservoirs in the Bear River Basin have capacities of more than 1,000 acre-feet. These are listed on the following page and are generally in order moving down the basin.

Irrigation

Approximately 483,000 acres of land are presently irrigated in the Bear River Basin. The distribution of these lands by counties is shown in the table on page 27. About half of the land is irrigated from the Bear River and half from tributary streams. Approximately 400 irrigation systems owned by organizations or individuals operate in the area. The number of irrigation systems and the acreage served have not increased substantially in the past 60 years.

The largest irrigation system in the basin is operated by the Utah-Idaho Sugar Company. The company's West Side and Hammond East Side Canals divert near the top of Cutler Dam and serve about 65,000 acres of land in Box Elder County, Utah. These canals receive natural flows of Bear River and substantial amounts of Bear Lake water delivered under contract with the Utah Power & Light Company which operates the Lifton Pumping Plant at the lake. A few other irrigation systems which divert from Bear River have acquired lesser amounts of Bear Lake water by contracts with the power company.

Data on 15 of the larger irrigation systems, each serving more than 5,000 acres, are tabulated on page 36.

Existing storage reservoirs in Bear River Basin

Reservoir	County	Water source	Active capacity (acre-feet)	Use symbol[1]
Whitney	Summit	W. Fork Bear River	4,700	I.R.
Sulphur Creek	Uinta	Sulphur Creek	7,100	I.R.
Neponset[2]	Rich	Bear River	6,900	I.
Woodruff Narrows	Uinta	Bear River	26,500	I.R.
Woodruff Creek[3]	Rich	Woodruff Creek	3,600	
Birch Creek	Rich	Birch Creek	2,260	I.R.
Bear and Mud Lakes[2]	Rich and Bear Lake	Bear River	1,452,000	I.P.R.
Montpelier Creek[3]	Bear Lake	Montpelier Creek	3,840	I.R.
Soda Creek	Caribou	Soda Creek	2,500	I.
Treasureton	Franklin	Battle Creek	1,200	I.R.
Winder[2]	Franklin	Bear Lake and Mink Creek	1,930	I.R.
Condie[2]	Franklin	Bear Lake and Mink Creek	2,200	I.R.
Twin Lakes[2]	Franklin	Bear Lake and Mink Creek	13,950	I.R.
Weston Creek	Franklin	Weston Creek	2,066	I.R.
Glendale	Franklin	Worm and Mink Creeks and Cub River	5,780	I.R.
Foster[2]	Franklin	Cub River	3,500	I.R.
Lamont[2]	Franklin	Cub River	2,400	I.R.
Porcupine	Cache	East Fork Little Bear River	12,800	I.R.
Hyrum	Cache	Little Bear River	15,280	I.R.
Newton	Cache	Clarkston Creek	5,370	I.R.
Daniels	Oneida	Little Malad River	7,800	I.R.
Upper Pleasantview	Oneida	Big Malad River	1,260	I.R.
Devil Creek[3]	Oneida	Devil Creek	3,800	I.R.
Crowthers	Oneida	Spring Creek	1,056	I.P.R.
Henderson	Oneida	Deep Creek	5,400	I.R.

[1] Symbols: I = irrigation, P = power, R = recreation, M = municipal.

[2] Offstream.

[3] Under construction.

Larger irrigation systems--Bear River Basin

Name of system	Water source	Area irrigated (acres)	Average annual water supply (acre-feet)
	Uinta County, Wyo., and Rich County, Utah		
Chapman Canal Co.	Bear River[1]	[2]14,395	12,800
	Rich County, Utah		
B Q West Side Canal Co.	Bear River	5,813	27,000
Crawford Thompson Canal Co.	Bear River	5,635	19,700
Randolph Sage Creek Canal Co.	Bear River	9,380	13,400
Randolph Woodruff Canal Co.	Bear River	9,550	31,300
	Bear Lake County, Idaho		
Black Otter and Peg Leg Co.	Bear River	5,872	16,400
West Fork Irrigation Co.	Bear River	5,712	13,600
	Caribou County, Idaho		
Last Chance Canal Co.	Bear River[3]	24,000	95,000
	Franklin County, Idaho		
Twin Lakes Canal Co.	Mink Creek[3]	17,421	34,000
Preston Whitney Irrigation Co.	Cub River	5,500	15,000
	Franklin County, Idaho, and Cache County, Utah		
Cub River Irrigation Co.	Cub and Bear Rivers[4]	29,000	30,000
West Cache Irrigation Co.	Bear River[3][5]	14,860	38,000
	Cache County, Utah		
Richmond Irrigation Co.	Cherry, High, and City Creeks and wells	10,000	[6]
South Cache Water Users Assn.	Little Bear River[7]	6,110	14,000
	Box Elder County, Utah		
Utah-Idaho Sugar Co.	Bear River[3]	65,000	216,000

1/ Storage provided in offstream Neponset Reservoir.

2/ Includes 1,155 acres in Uinta County and 13,240 acres in Rich County. Water supply shown is for Rich County lands; quantity for Uinta County lands is not known.

3/ Bear Lake water also supplied under contract.

4/ About 13,500 acres of land and 14,000 acre-feet of water pertain to Franklin County; 15,500 acres of land and 16,000 acre-feet of water to Cache County.

5/ 3,330 acres of land and 9,000 acre-feet of water pertain to Franklin County; 11,530 acres and 29,000 acre-feet to Cache County.

6/ Data not available.

7/ Storage provided in Hyrum Reservoir.

Hydroelectric power

About 94 percent of the hydroelectric generating capacity in the Bear River Basin is provided by the five Bear River plants of the Utah Power & Light Company. The company also operates three other small plants on tributary streams. Five small hydroelectric plants are operated by municipalities and one by the Utah State University. The average annual power generation at the plants in the basin is about 341,900,000 kilowatt-hours, with about 90 percent of this produced at the five Bear River powerplants. Data on the various plants are tabulated below.

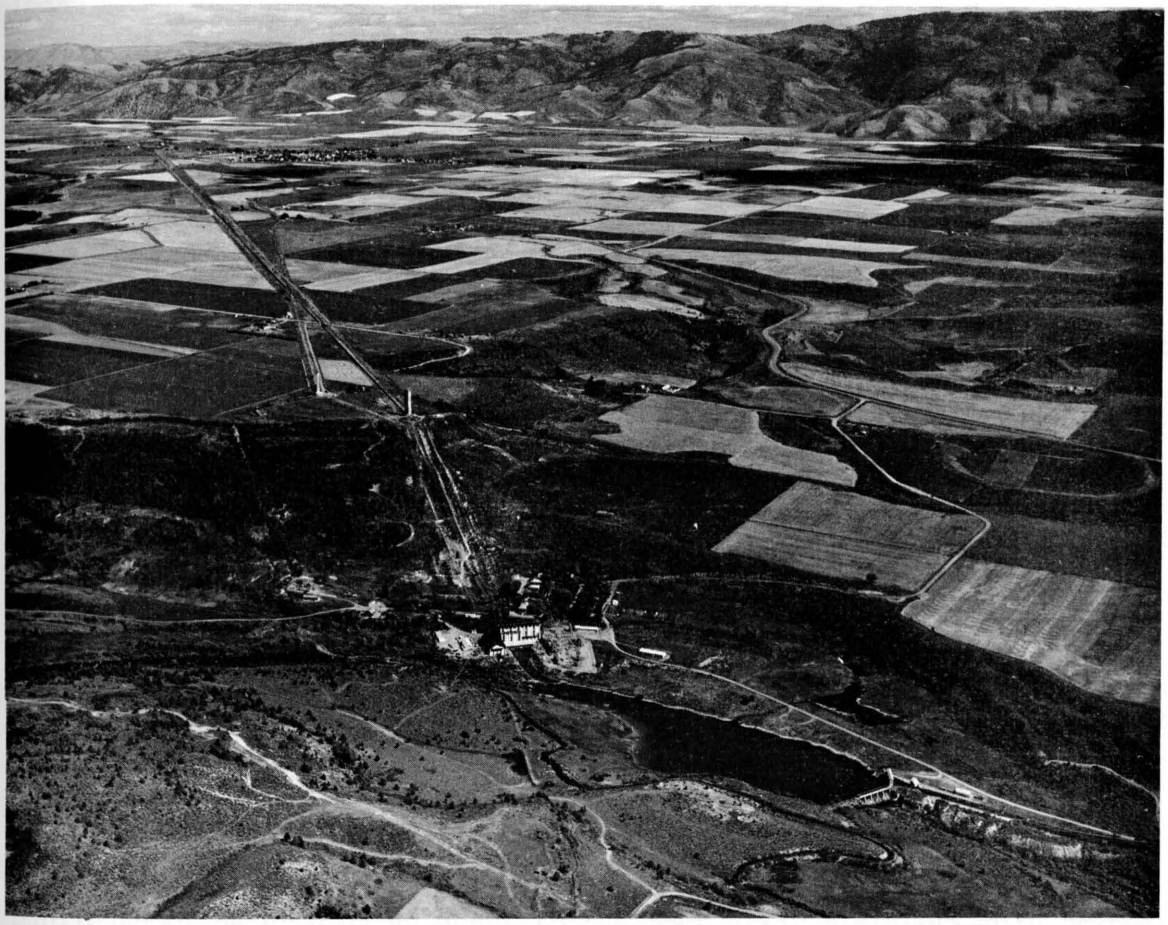
Existing hydroelectric powerplants

Plant name	Stream	Owner	Static head (feet)	Installed capacity (kilowatts)
Soda	Bear River	Utah Power & Light Co.	79	14,000
Grace	Bear River	Utah Power & Light Co.	526	44,000
Cove	Bear River	Utah Power & Light Co.	98	7,500
Oneida	Bear River	Utah Power & Light Co.	145	30,000
Cutler	Bear River	Utah Power & Light Co.	127	30,000
Swan Creek	Swan Creek	Utah Power & Light Co.	120	300
Paris Creek	Paris Creek	Utah Power & Light Co.	346	650
Logan	Logan River	Utah Power & Light Co.	213	2,000
Logan (State)	Logan River	Utah State University	30	450
Logan City	Logan River	Logan City	99	1,400
Soda Springs No. 1	Soda Creek	Soda Springs City	50	120
Soda Springs No. 2	Soda Creek	Soda Springs City	20	50
Soda Springs No. 3	Soda Creek	Soda Springs City	84	400
Hyrum City	Blacksmith Fork	Hyrum City	76	400
Total				131,270

The Soda, Oneida, Paris Creek, and Logan Powerplants of the Utah Power & Light Company have Federal licenses as does the Hyrum City Powerplant. All of the licenses expire June 30, 1970, except that of the Soda Powerplant, which expires July 4, 1973. Applications for licenses have been filed with the Federal Power Commission for the Grace, Cove, and Cutler Powerplants.

Prior to 1932 the Utah Power & Light Company made year-round drafts on Bear Lake for power generation in addition to seasonal releases for irrigation. These drafts, together with a prolonged drouth, resulted in a gradual lowering of the lake surface during the 1930's. Consequently the company revised its operation with the intention of refilling the lake over a period of years. Except for infrequent releases to provide storage capacity for spring runoff, the company now releases large amounts

of water from the lake only during the irrigation season. The revised operation substantially reduced the energy output of the Bear River powerplants during the nonirrigation season, and at times during the irrigation season it caused suspension of operations at the Cutler Powerplant which is located below all important irrigation diversions from Bear River. With their water supply thus limited, the Bear River powerplants are now used principally for peaking operations. The power company's base load is supplied largely from fuel-electric plants and other sources. Under the new plan of operation the level of Bear Lake again rose in an irregular pattern, reaching full stage in 1950 for the first time since 1923. Since 1950 the lake has been maintained at comparatively high levels.



Grace Powerplant of Utah Power & Light Company--Grace, Idaho, is in left background.

Municipal and industrial water

Most of the farmers in the Bear River Basin reside in communities and receive their domestic and stock water from municipal systems. Those

who reside on farms outside of municipalities obtain water from springs or wells. During the irrigation season stock water is obtained mostly from irrigation canals.

Virtually all of the communities divert spring water from the mountains into pipe systems for municipal use. Some of them also have wells which are drawn on during seasons of heavy use. As a rule chlorination is the only treatment required for water for municipal use. Costs of the municipal water are relatively low and daily per capita consumption is high. The greatest potential needs for additional water for industry are in the phosphate-processing area extending from Montpelier to Soda Springs, Idaho, and in the developing industrial area near Great Salt Lake.

Fish and wildlife development

A number of important refuges and other facilities for wildlife are located in the Bear River Basin area. State-operated fish hatcheries at Logan, Utah, and Grace, Idaho, provide fish stock for basin streams.

The Bear River Migratory Bird Refuge, a Federal project administered by the Bureau of Sport Fisheries and Wildlife and one of the largest waterfowl refuges in the United States, is located at the mouth of Bear River near Great Salt Lake. Nearly 50,000 birds are produced in this refuge each year. The refuge covers an area of about 65,000 acres. About 25,000 acres have been developed and are divided by dikes into five units that provide nesting, resting, and feeding grounds for millions of waterfowl and other migratory birds during their semiannual migrations. A 14,700-acre addition to the refuge has been proposed by the Bureau of Sport Fisheries and Wildlife. The Mud Lake area adjacent to Bear Lake in Idaho has recently been designated the Bear Lake National Wildlife Refuge. This 17,000-acre unit provides valuable breeding and nesting habitat for waterfowl, particularly Canada geese. Developments are planned that will include dikes, roads, fences, nesting islands, buildings, and other facilities.

State fish and game facilities include the Hardware Ranch Game Management Unit in Blacksmith Fork Canyon in Cache County, Utah, and the Locomotive Springs Unit in Box Elder County, Utah. The Hardware Ranch Unit is operated for the management of big game such as deer and elk, whereas Locomotive Springs Unit is operated for fish and waterfowl. The public shooting grounds adjacent to the Bear River Migratory Bird Refuge and the Salt Creek Waterfowl Management Area are also managed by the Utah State Fish and Game Department for waterfowl.

Portions of the national refuges and State-operated units as well as some adjacent private lands are open to public hunting. Several private gun and duck clubs are located in the basin, particularly along the lower reaches of the Bear and Malad Rivers. These clubs restrict hunting rights to members only.

Recreational development

Significant development has been made at many of the natural recreational attractions mentioned in the preceding chapter. Along the shores of Bear Lake in both Idaho and Utah are several vacation resorts and numerous summer homes. Boating, water skiing, and swimming are the principal water-oriented sports at the lake. Numerous camp sites and picnic areas administered by the Forest Service are located in the parts of the basin that are within the Cache and Caribou National Forests. State parks have been established or are being developed on the shores of water bodies in each of the three basin States. These include a park on the north shore of the Woodruff Narrows Reservoir in Wyoming, the North Beach State Park on Bear Lake in Idaho, and the Hyrum, Willard, Bear Lake, and Bear Lake (south) State Parks in Utah. The Beaver Mountain Ski Area has been privately developed in Logan Canyon. Many private summer homes are maintained in Logan Canyon and elsewhere by both basin residents and others.

Ground water

Ground water has been developed in varying amounts in all of the valleys of the Bear River Basin area. A total of 4,408 wells has been drilled. The number of wells in each valley, segregated by purposes of water use, is shown in the table below.

Existing wells in Bear River Basin area

	Pumped wells					
Valley	Irrigation	Domestic and livestock	Municipal	Industry	Flowing wells[1]	Total
Upper Bear River						
Wyoming	32	51	5			88
Utah	4	231	2	1		238
Idaho	8	6				14
Bear Lake						
Utah	24	323	2	1		350
Idaho	22	55	3	1		81
Gem and Gentile, Idaho[2]	19	92	2	14		127
Cache						
Idaho	48		4	2	275	329
Utah	20		17	8	1,526	1,571
Lower Bear River, Utah	105	1,126	17	5		1,253
Malad, Idaho	56		1		300	357
Total	338	1,884	53	32	2,101	4,408

1/ Used partly for irrigation and partly for domestic, stock watering, and industrial purposes.

2/ Includes Soda Springs area.

The greatest ground water developments are in Cache, Malad, and Gem Valleys where deep, large-diameter wells have been drilled, primarily to supplement surface irrigation water supplies. In Cache Valley wells also produce substantial amounts of water for municipal and industrial uses. Numerous farmsteads in all of the valleys depend upon wells for domestic and stock-watering uses.

Complete records have not been kept of the withdrawals from all wells. Available information indicates that total withdrawals were 28,600 acre-feet in Cache Valley in 1967 and approximately 25,000 acre-feet from Malad Valley in 1964.

The ground water potential in the valleys of the river basin area is discussed below.

Upper and Lower Bear River Valleys and Bear Lake Valley

The ground water potential in the Upper and Lower Bear River Valleys and Bear Lake Valley is undetermined but is believed to be limited. Aquifers exist only in locations of extensive alluvial deposits, primarily along stream channels. In the Upper Bear River Valley the aquifers are quite thick and of coarse materials but limited to flood plain areas. The better aquifers have proved to be permeable and productive, supporting pumped well discharges of 700 to 1,500 gallons per minute. In the Bear Lake Valley the aquifers are mostly thin with small-sized particles and rather low permeability. Aquifers in the Lower Bear River Valley have similar characteristics to those of Bear Lake Valley although they are composed of both stream- and lake-deposited sediments. Aquifers capable of supplying irrigation, municipal, and industrial wells exist in limited areas.

Gem and Gentile Valleys

Permeable and productive aquifers underlie the larger parts of Gem and Gentile Valleys, including the Soda Springs area upstream from Gem Valley. The major aquifers consist of fractured and cavernous basalt stratified with cinders. Some aquifers, particularly in Gentile Valley, are composed of alluvial sand and gravel stratified with clay.

Cache Valley

Of all the valleys of the Bear River Basin area, Cache Valley has the greatest potential for additional ground water development. Aquifers along the valley periphery near the mouths of inflowing streams consist of thick, permeable gravel layers between clay layers. The gravel becomes finer and the layers thinner and less permeable toward the valley bottom. In the central part of the valley the aquifers consist mostly of sand between clay layers. The most productive areas extend between Hyrum and Richmond, Utah, on the east side of the valley and between Weston and

Swan Lake, Idaho, on the west side. The annual ground water recharge in these areas far exceeds present withdrawals from wells.

A detailed investigation of the Cache Valley ground water potential is being made by the Geological Survey in cooperation with the States of Utah and Idaho, Soil Conservation Service, Bureau of Reclamation, and local interests. The results of this study are scheduled to be published in 1971.

Malad Valley

One of the larger ground water reservoirs of the Bear River Basin underlies Malad Valley. The aquifers are in sand and gravel stratified with clay. Average irrigation well discharges of 2 second-feet indicate that the aquifers have good permeability. Since 1964 between 11,000 and 17,000 acre-feet have been pumped annually for irrigation. This has slightly diminished the artesian well area and has caused minor lowering of the static ground water level.

A preliminary study of the potential for ground water developments in Malad Valley is being made by the Geological Survey in cooperation with the State of Idaho. Although the study has not been concluded, indications are that an additional large-scale development is possible but that it would require a lowering of the ground water levels sufficient to curtail the natural discharge from the aquifers and stop artesian well flow. A comprehensive investigation would be necessary to evaluate the physical feasibility and economic justification of such a development.

Ground Water Investigations

Reconnaissance ground water investigations have been completed or are now in progress for nearly all valleys of the Bear River Basin. Completed studies are reported in water supply papers published by the Geological Survey and in reports by the Utah State Engineer, some dating back to 1913. An inventory of wells and ground water use in Cache Valley was made by the State of Utah and the Federal Works Progress Administration in 1938-39. The findings are published in the State Engineer's Biennial Report of 1940. Ground water investigations in Malad Valley by the Bureau of Reclamation have been underway since 1965. In addition to current investigations in Cache and Malad Valleys previously mentioned, the Geological Survey is now making reconnaissance investigations in all the valleys within the Idaho portion of the Bear River Basin area not previously completed.

CHAPTER IV

GUIDELINES TO DEVELOPMENT

New water resource developments in the Bear River Basin face physical, institutional, and economic limitations that will need to be taken into account in the formulation of development plans. The problems involve matching available water supplies so far as possible with the needs for water both in time and place and in designing projects that will maximize benefits, minimize costs, and gain public approval with due consideration to (1) the physical limitations of construction sites, (2) established water rights and water use patterns, (3) the provisions of the Bear River Compact, and (4) future understandings among the States as to the division of Bear River water. Essentially no water is available for new development below Bear Lake except by conversion from nonconsumptive uses for power generation to consumptive uses for other purposes. These problems are discussed in broad scope in this chapter with no attempt to relate them to specific projects.

Water Needs

About 2,140,000 acre-feet of water annually would be required at points of diversion to supplement present irrigation supplies in providing full irrigation service to the arable lands shown in the table on page 27. This is more water than is available for new developments in the Bear River Basin. It would not be practical to provide water for all of these lands, however, even if the supply were sufficient.

Needs for additional municipal and industrial water cannot be determined as precisely with respect to time and place as irrigation needs. A requirement for 153,000 acre-feet of additional water for these purposes by year 2020 is estimated. The principal needs are expected to result from industrial developments and population growth in Bear Lake and Caribou Counties, Idaho, and Cache and Box Elder Counties, Utah. The Bear Lake and Caribou County need is anticipated primarily from an expansion in the mining and processing of phosphate ore and associated municipal growth. Municipal and industrial water needs are so important to the economy of the area that they will no doubt be filled by whatever means are necessary as they arise. Present requirements for additional irrigation water and anticipated needs by year 2020 for additional municipal and industrial water are tabulated by counties on the following page.

Water needs for future developments[1/]
(Unit--acre-feet annually)

State and County	Irrigation service			Municipal and industrial use to 2020
	Supplemental service	Full service	Total	
Wyoming				
Uinta	25,000	75,000	100,000	900
Lincoln	5,000	145,000	150,000	600
Subtotal	30,000	220,000	250,000	1,500
Idaho				
Bear Lake	75,000	145,000	220,000	8,000
Caribou	25,000	95,000	120,000	35,500
Bannock		15,000	15,000	
Franklin	35,000	195,000	230,000	
Oneida	25,000	290,000	315,000	
Subtotal	160,000	740,000	900,000	43,500
Utah				
Summit		10,000	10,000	
Rich	25,000	210,000	235,000	
Cache	45,000	320,000	365,000	48,000
Box Elder		380,000	380,000	60,000
Subtotal	70,000	920,000	990,000	108,000
Total	260,000	1,880,000	2,140,000	153,000

1/ Requirement at point of diversion. About one-half of amount diverted would be consumed and remainder would return to river system.

The annual water need for the Bear River Migratory Bird Refuge is placed by the Bureau of Sport Fisheries and Wildlife at about 341,000 acre-feet, of which about 218,000 acre-feet is presently available within the pattern of need. This would leave a need for an additional 123,000 acre-feet of regulated water. Expansions of wildlife refuges, mentioned in Chapter III, that are in various stages of planning also present a potential need for substantial quantities of water. The Bureau of Sport Fisheries and Wildlife also estimates an annual requirement of 40,000 acre-feet for a 14,700-acre expansion of the Bear River Refuge. Lands adjoining the refuge are managed for waterfowl purposes by the State of Utah. Their requirements for additional water are estimated at 166,000 acre-feet annually.

The Bureau of Sport Fisheries and Wildlife favors development of the Coulam National Wildlife Refuge in Cache Valley southeast of Oxford, Idaho, as a feature of a multiple-purpose reclamation development on Bear River. For optimum benefit the refuge would require 19,300 acre-feet of Bear River water annually to supplement natural inflows from Deep Creek.

A need for the maintenance or augmentation of natural streamflows for fish is felt in a number of places in the Bear River Basin.

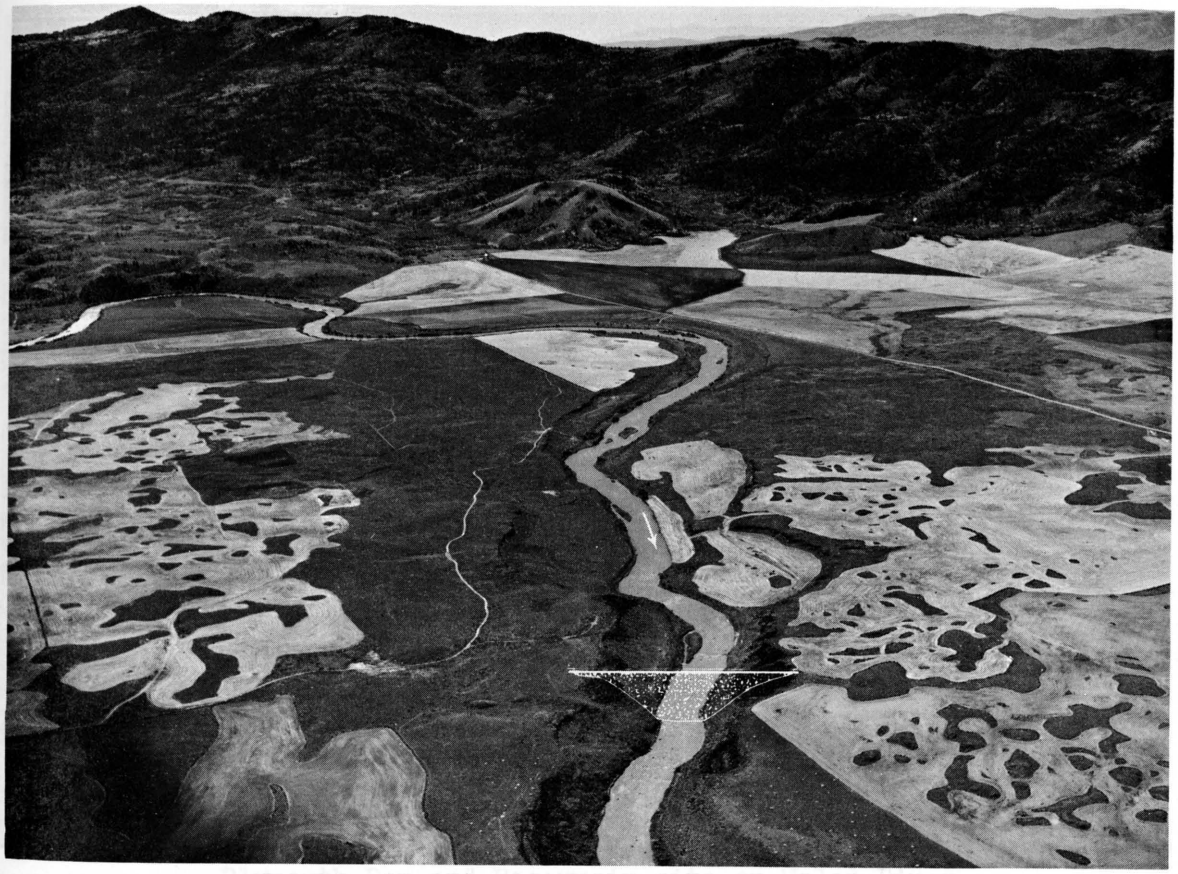
Bear River Migratory Bird Refuge. Administration buildings in foreground.

Site of potential Coulam National Wildlife Refuge. View looking north

Water requirements for fish, wildlife, and recreational purposes should receive attention in planning further water resource developments and should be satisfied to the extent practical. Opportunities are often presented to incorporate these uses into multiple-purpose development plans, using the water either before or after it is used for other purposes.

Undeveloped Reservoir Sites

Much of the water that flows in Bear River and its tributaries brings little or no economic return except for power production because it is not available when needed. Uncontrolled, heavy runoff is often a menace, causing flood damage along its course. It is the flow that now occurs when not needed that provides a potential for further development through storage regulation.



Caribou Dam Site on Bear River south of Soda Springs, Idaho.

The selection of favorable sites for dams and reservoirs presents a major problem in planning development of the Bear River system. There is a scarcity of good sites that are properly located with respect to water supply and places of use, adequate topographically and geologically, and not prohibitive in costs for right-of-way and construction.

Data on 35 undeveloped dam and reservoir sites are presented in the table on the following page. The site locations are shown on the map on page 49. The sites were selected as being the more favorable of about 70 sites that have been considered by the Bureau of Reclamation. Some of the dam sites in this listing represent alternatives for the same reservoir basins. The estimated volume of dam embankment per acre-foot of storage capacity, shown in the last column of the table, is an indication of the relative attractiveness of the sites, but not a conclusive one. Other factors such as spillway and outlet requirements and costs, right-of-way costs, geological conditions, and location with respect to water supply are important considerations.

Plymouth Dam and Reservoir site on Malad River south of Plymouth, Utah.

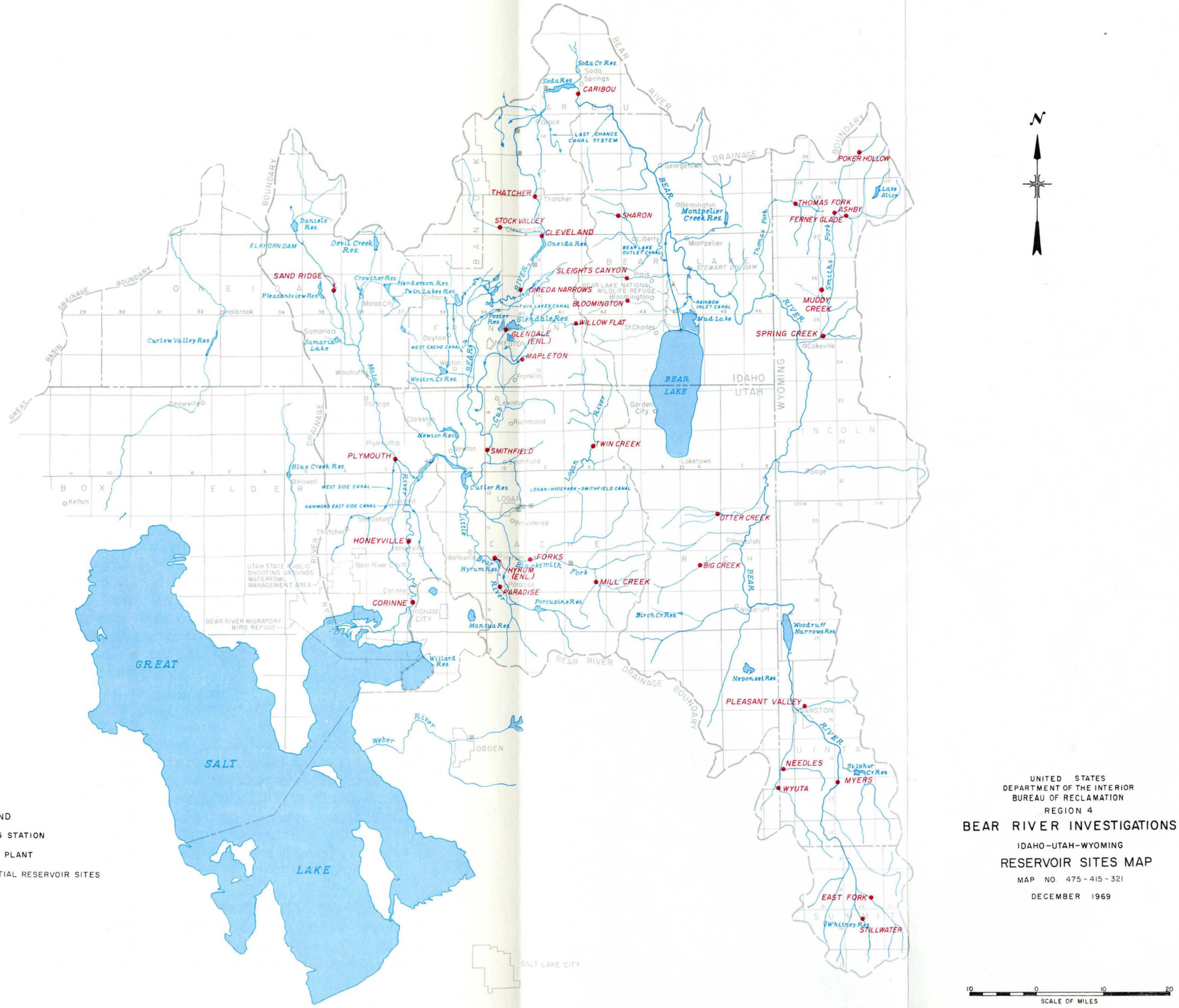
Undeveloped reservoir sites

Name of site	County	Water source	Reservoir capacity[1] (acre-feet)	Dam dimensions (feet) Height	Dam dimensions (feet) Crest length	Dam embankment per acre-foot of reservoir capacity (cubic yards)
		Wyoming				
Myers[2]	Uinta	Bear River	15,000	86	1,310	70.7
Wyuta[2]	Uinta	Yellow Creek and Bear River	146,000	170	1,850	16.6
Needles	Uinta	Coyote Creek and Bear River	35,000	111	825	15.5
Pleasant Valley	Uinta	Pleasant Valley Creek	50,000	117	1,000	14.6
Poker Hollow	Lincoln	Smiths Fork	6,000	98	690	88.7
Ferney Glade	Lincoln	Hobble Creek	10,000	105	600	29.3
Ashby	Lincoln	Smiths Fork	21,000	125	1,090	47.6
Muddy Creek[3]	Lincoln	Muddy Creek	5,000	115	800	
Spring Creek[3]	Lincoln	Spring Creek	4,500	75	1,200	
Thomas Fork	Lincoln	Thomas Fork	11,500	117	710	51.9
		Idaho				
Bloomington	Bear Lake	Bloomington Creek	2,500	70	535	68.0
Sleights Canyon	Bear Lake	Sleights Canyon	4,400	97	430	46.6
Sharon	Bear Lake	Emigration Creek	3,000	90	740	113.3
Caribou	Caribou	Bear River	40,000	76	3,680	10.5
Thatcher	Franklin	Bear River	90,000	49	814	3.2
Stock Valley	Franklin	Cottonwood Creek	8,500	58	1,650	40.1
Cleveland	Franklin	Bear River	123,000	60	540	1.8
Oneida Narrows	Franklin	Bear River	435,000	314	1,245	12.4
Oneida Narrows	Franklin	Bear River	140,000	259	1,070	24.4
Glendale Enlargement	Franklin	Worm Creek	23,000	130	1,550	71.8
Willow Flat	Franklin	Cub River	3,750	88	830	60.4
Mapleton	Franklin	Cub River	34,486	160	1,940	142.5
Sand Ridge	Oneida	Little Malad River	16,200	138	3,800	139.0
		Utah				
Stillwater	Summit	Stillwater Fork of Bear River	9,500	78	1,350	58.5
East Fork	Summit	East Fork of Bear River	8,500	92	2,370	94.1
Big Creek	Rich	Big Creek	3,600	60	1,330	154.2
Otter Creek	Rich	Otter Creek	5,000	64	1,072	93.9
Smithfield	Cache	Bear River	70,000	53	17,220	25.5
Twin Creek	Cache	Logan River	20,000	215	675	82.5
Mill Creek	Cache	Blacksmith Fork	10,010	125	860	98.7
Forks	Cache	Blacksmith Fork	47,000	230	1,030	75.3
Paradise	Cache	Little Bear River	20,000	100	3,430	55.0
Hyrum Enlargement	Cache	Little Bear River	33,700	116	3,140	13.5
Plymouth	Box Elder	Malad River and Bear River	150,000	85	3,650	4.4
Honeyville	Box Elder	Bear River	120,000	76	1,650	3.1
Corinne[3]	Box Elder	Bear River	200,000	25	50,000	58.5

1/ Capacity for dam height indicated.

2/ Dam site is in Utah, but greater part of reservoir basin and 30 miles of stream channel below dam site are in Wyoming.

3/ Information shown is preliminary; no detailed surveys have been made.



LEGEND

- GAGING STATION
- POWER PLANT
- POTENTIAL RESERVOIR SITES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

REGION 4

BEAR RIVER INVESTIGATIONS

IDAHO–UTAH–WYOMING

RESERVOIR SITES MAP

MAP NO. 475-415-321

DECEMBER 1969

10 0 10 20
SCALE OF MILES

Water Rights

Bear River Compact

Future water resource developments in the Bear River Basin will need to be in accord with the terms of the Bear River Compact, including any compact amendments that may have been made at the time. The compact was signed February 4, 1955, by representatives of Idaho, Utah, and Wyoming and the United States. It was later ratified by the legislature of each of the three States, and Federal consent to it was given in legislation signed by the President March 17, 1958.

The compact created the Bear River Commission, an administrative agency composed of nine commissioners--three from each of the signatory States, and, if appointed by the President, one additional commissioner representing the United States of America who shall serve as chairman without vote.

Provisions of the compact will be reviewed by the Commission at intervals not exceeding 20 years. The Commission may propose amendments to the compact which will become effective if ratified by legislatures of the signatory States and consented to by Congress.

The compact divides the Bear River into three divisions. The Upper Division includes the portion of the river from its headwaters to and including Pixley Dam, an irrigation diversion dam located about 10 miles south of Cokeville, Wyo. The Central Division includes the portion of Bear River from Pixley Dam to and including Stewart Dam which serves to divert river water for storage in Bear Lake. The Lower Division includes the portion of the river from Stewart Dam to Great Salt Lake. The compact provides that direct flow water rights are to be administered under State law in each State and provides a basis for distributing the water among the States when there is a water emergency.

Additional storage above Stewart Dam beyond that existing at the time of the compact is permitted in these annual amounts: Idaho 1,000 acre-feet and Utah and Wyoming 35,500 acre-feet to be divided equally. The compact provides for an irrigation reserve in Bear Lake which shall not be released solely for power except in an emergency. The reserve is defined as the water below certain lake elevations. From lake capacity determinations it is computed that the irrigation reserve would range from about 681,000 acre-feet when the compact was ratified to about 800,000 acre-feet when full storage development above Stewart Dam is made as permitted by the compact.

Since river inflows below Bear Lake are appropriated for power and other uses the Bear River Compact did not apportion the water among the States for further development. It declared, however, that the policy of the States is to encourage additional projects for the development

of the water resources of the Bear River to the maximum beneficial use with a minimum of waste. In furtherance of this policy, authority is given within the limitations of the compact to investigate, plan, construct, and operate such projects without regard to State boundaries, provided that project water rights are subjected to prior rights.

Present water appropriations

Water rights on Bear River and its tributaries are of record in court decrees, water applications or use permits, and claims in pending adjudication proceedings. Numerous rights are also claimed to have been established by water use, particularly on tributaries, even though they have not been adjudicated or otherwise made of record.

Wyoming water rights are tabulated in a document on file in the office of the State Engineer, entitled, "Tabulation of Adjudicated Water Rights in the State of Wyoming--Water Division Number Four."

Water rights in Idaho above Stewart Dam are defined in a decree of the Fifth District Court of Idaho dated March 7, 1924, in the case of "Preston-Montpelier Irrigation Company vs. Dingle Irrigation Company, et al." Idaho rights below Stewart Dam are defined in the so-called Dietrich decree issued July 14, 1920, in the U.S. District Court of Idaho, Eastern Division, in the case of "Utah Power & Light Company vs. Last Chance Irrigation Company, et al." Decrees of Idaho's Fifth Judicial District Court define water rights on the Cub River (1924) and Maple Creek, a tributary (1905 and 1937).

The water rights in Cache County, Utah, and those covering diversions from Bear River at or above Cutler Dam for use in Box Elder County were decreed in the case of "Utah Power & Light Company vs. Richmond Irrigation Company," filed February 21, 1922, in the First Judicial District Court of Utah in and for Cache County. This decree is commonly known as the "Kimball decree." Later court decrees rendered or pending in the counties of Summit, Rich, Cache, and Box Elder, Utah, further define Utah water rights on the Bear River and its tributaries. It is presumed that through pending adjudication proceedings all previous decrees will be consolidated and that rights for both surface and ground water that are still unadjudicated will be defined.

Excluding rights of the Utah Power & Light Company, water rights on the main stem of the Bear River that have been established and applied to use in each of the States are summarized below.

Wyoming: 805 second-feet and 18,437 acre-feet annually for irrigation.

Idaho: 1,550 second-feet for irrigation.

Utah: 1,520 second-feet for irrigation, 13.5 second-feet for industrial use, and 1,000 second-feet for the Bear River Migratory Bird Refuge.

The Utah Power & Light Company has rights to divert Bear River water to Bear Lake for storage. It also has rights to store natural inflows to Bear Lake and Mud Lake and to divert natural flows of Bear River at its five hydroelectric powerplants on the river. Its rights are summarized below.

Water rights of Utah Power & Light Company

Source	Amount (second-feet)	Purpose
Bear Lake	300	Tributary inflow for storage
Mud Lake	200	Tributary inflow for storage
Bear River	5,500	Storage in Bear Lake
Bear River	1,500	Power at Soda plant
Bear River	1,000	Power at Grace plant
Bear River	1,500	Power at Cove plant
Bear River	2,500	Power at Oneida plant
Bear River	4,974	Power at Cutler plant

Irrigators using Bear Lake water contract with the power company to pay certain pumping charges. Lands receiving Bear Lake water are mostly in Cache and Lower Bear River Valleys where the water can be diverted below all of the company's powerplants except Cutler.

Of interest in a consideration of the amount of unappropriated water available for new developments are several applications for large amounts of water that have been filled in recent years in Idaho and Utah. The rights represented by these applications are as yet unconfirmed by proof of use and therefore were not included in the previous summaries of established and applied rights. The application data are summarized in the table on the following page.

Applications No. 39186 in Idaho and No. 37031 in Utah have been approved by appropriate State officials, but proofs of use have not been made. All other applications listed are as yet unapproved. Since water resource developments contemplated in some of the applications would duplicate other potential developments not all of the applications are expected to result in certificates of water right.

Recent water right applications

Application number	Applicant	Source	Storage site	Quantity of water: Acre-feet	Quantity of water: Second-feet	Priority
		Idaho applications				
39186	Caribou Water Dev. Co.	Bear River	Caribou	40,000		4-19-63
39296	Bureau of Reclamation	Bear River	Oneida Narrows		1,500	6-14-63
39297	Bureau of Reclamation	Bear River	Oneida Narrows	325,000		6-14-63
13-7007	Bureau of Reclamation	Cub River	Mapleton	45,000	500	6-6-69
		Utah applications				
27670	Utah Water and Power Board	Blacksmith Fork	Hardware Ranch	35,000	300	10-?-55
36722	Bureau of Reclamation	Bear River	Honeyville	150,000		2-9-65
36723	Bureau of Reclamation	Bear River	Honeyville		300	2-9-65
35428	Great Salt Lake Minerals and Chemicals Corp.1/	Bear River	Bear River Bay	75	50	8-9-63
37031	Great Salt Lake Minerals and Chemicals Corp.1/	Bear River	Bear River Bay	67,000		6-11-63
37076	Bureau of Reclamation	Bear and Logan Rivers and Summit Creek	Smithfield	160,000		7-8-65
37077	Bureau of Reclamation	Blacksmith Fork	Blacksmith Fork	50,000		7-8-65
37078	Bureau of Reclamation	Malad and Bear Rivers	Plymouth	125,000		7-8-65
37412	Utah Salt Land Co.	Bear River	(no storage)		150	1-11-66
37434	Utah Department of Fish and Game	Bear River	Refuge near Great Salt Lake		2/638	1-24-66

1/ Successor to Lithium Corporation of America, Inc., which filed application; construction of works underway.

2/ Diversions limited to 200,000 acre-feet annually.

Water Available for New Uses

The range of streamflows and stream diversions at key gaging stations in the Bear River Basin and the range in the active storage content of Bear Lake are shown in the table on page 21. This information is of interest in indicating the magnitude of water supplies at various points in the basin. Recorded streamflows and lake content must be related to water rights and compact provisions, however, for an appraisal of the amount of water available for new uses. Such an appraisal, under terms of the compact, is segregated logically to areas above and below Bear Lake.

New uses above Bear Lake

The Bear River Compact provided for only limited storage development on the Bear River system above Stewart Dam (Bear Lake) beyond that in existence at the time the compact was signed. The Utah portion of the storage allowance and about 13,500 acre-feet of the Wyoming portion have already been developed or are being developed in the Woodruff Narrows, Woodruff Creek, Hilliard, and other reservoirs. Thus 4,250 acre-feet of the Wyoming portion and the full 1,000 acre-feet of the Idaho allotment are yet to be developed.

Woodruff Narrows Dam and Reservoir on Bear River in Uinta County, Wyo.

Physically much of the water which enters Bear Lake could be consumed by future developments in the area of its origin and replaced to present downstream water-consuming uses by inflows to the river system below Bear Lake. The replacement would be dependent upon provision of adequate storage facilities below the lake. The replacement, if made under existing compact provisions, would adversely affect power rights on Bear River and potentialities for converting water from present power uses to higher value consumptive uses below the lake. Future developments above Bear Lake without compact modification would be obligated to provide double storage--above the lake for local use and below the lake for replacement. Unusually high-value water use would be required to justify these developments economically.

Woodruff Narrows Dam and Reservoir on Bear River in Uinta County, Wyo.

Physically much of the water which enters Bear Lake could be consumed by future developments in the area of its origin and replaced to present downstream water-consuming uses by inflows to the river system below Bear Lake. The replacement would be dependent upon provision of adequate storage facilities below the lake. The replacement, if made under existing compact provisions, would adversely affect power rights on Bear River and potentialities for converting water from present power uses to higher value consumptive uses below the lake. Future developments above Bear Lake without compact modification would be obligated to provide double storage--above the lake for local use and below the lake for replacement. Unusually high-value water use would be required to justify these developments economically.

respect to any resulting losses to hydroelectric power generation. The effect of new stream depletions on the salinity of the remaining river flows would need to be taken into account.

The annual composition of the flow at Corinne and the requirements of the Bear River Migratory Bird Refuge are shown graphically on the following page. A second chart on page 58 shows the portion of the present modified gain below Bear Lake that occurs above Oneida Narrows. It distinguishes between the portion of this water that would need to pass the Narrows for present downstream uses including the West Cache Canal and other minor diversions, averaging 57,000 acre-feet annually, and the portion that would be available for a new storage development at the Narrows, averaging 235,000 acre-feet annually. The downstream requirements shown in blue on the second chart do not include uses that are served by river inflows below Oneida Narrows or those that are supplied under contract by water released from Bear Lake.

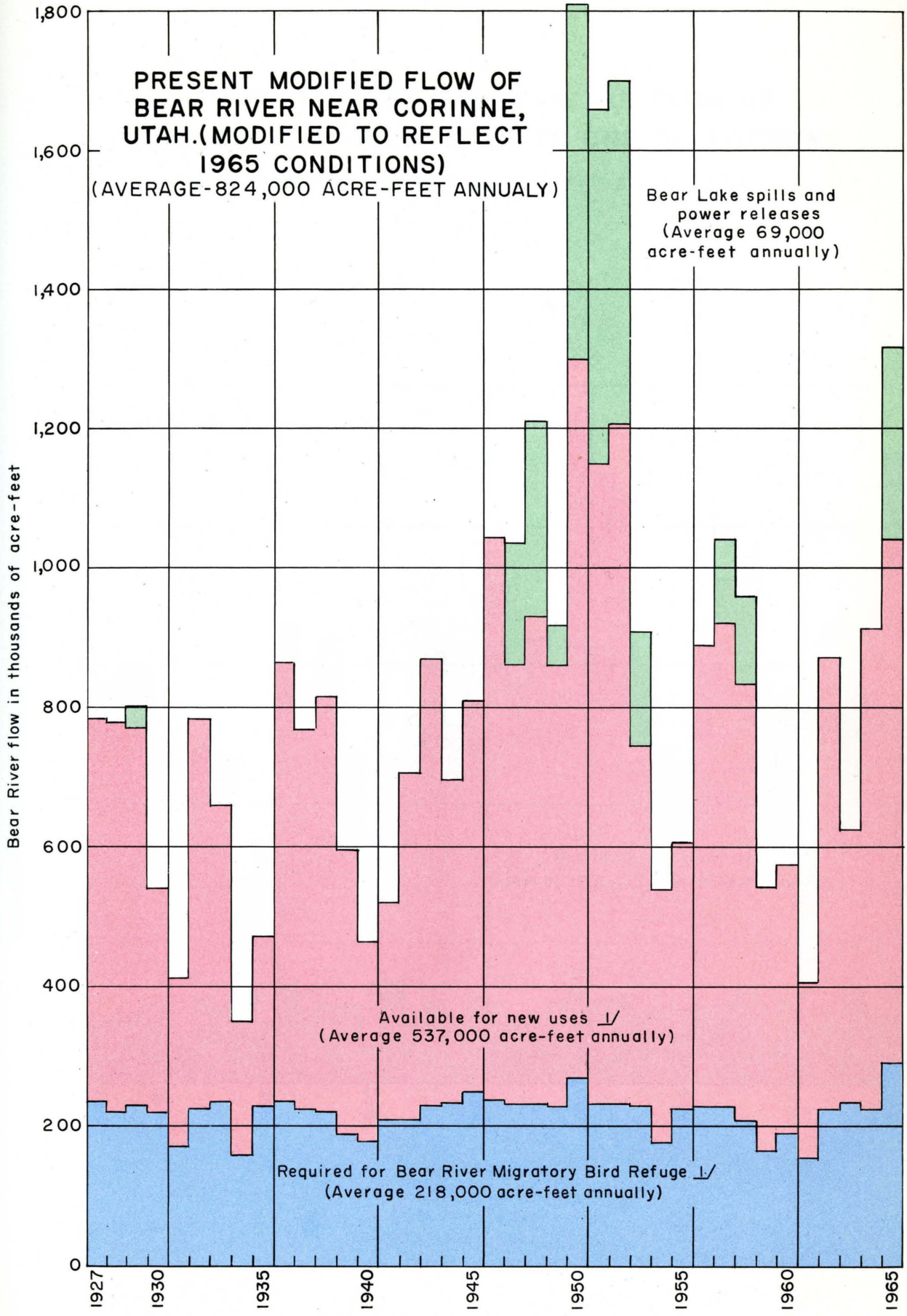
Modification of Bear Lake operation

The annual average of 69,000 acre-feet of water that is released from Bear Lake only for power generation or that is spilled at Bear Lake or Stewart Dam could be largely controlled at the lake or in storage sites above or below the lake, permitting further consumptive water uses. Modification of the operation of Bear Lake to effect this additional water conservation would require agreement by the three States of the Bear River Basin and hence is not included in any of the development potentialities mentioned in Chapter V. Modification of the lake operation may adversely affect power generation at the five Bear River plants of the Utah Power & Light Company.

Economic Considerations

The more easily justified projects in the Bear River Basin have already been built and some of these complicate the planning of greater future developments. The potential for further development is great, however, and with sound planning benefits from new water uses can be maximized and losses at existing powerplants held to a practical minimum.

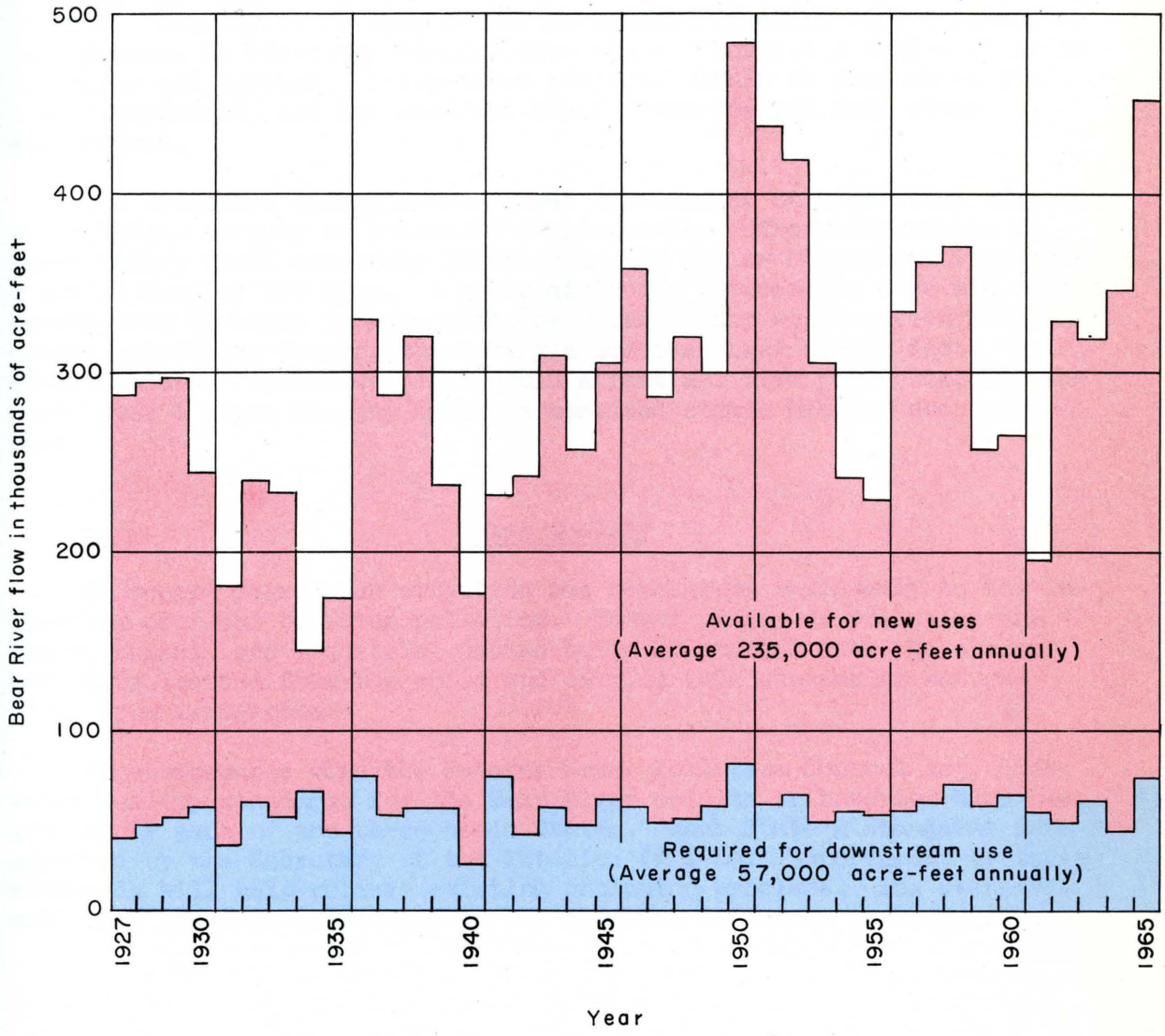
An important objective in project plan formulation is to serve so far as practical all multiple needs for water including such needs as irrigation, municipal and industrial use, fish and wildlife development, recreation, flood control, power production, and water quality control. Multiple-use benefits tend to improve a project's benefit-cost relationship and permit an allocation of costs to various purposes. Costs allocated to some purposes are partly or wholly nonreimbursable and may relieve the repayment burden of the irrigators.



1/ The combined red and blue areas represent river gains below Bear Lake

MODIFIED NET GAINS IN THE FLOW OF BEAR RIVER—BEAR LAKE TO ONEIDA NARROWS

(AVERAGE-292,000 ACRE-FEET ANNUALLY)



As a rule project farmers will require assistance in the payment of costs allocated to irrigation. Sources of assistance would be determined in the course of detailed planning of any development. Power revenues in the Columbia River Basin Account may be one source of assistance.

Each reservoir site will, of course, be considered on its engineering and economic merit. As a rule, however, sites on Bear River are more favorable than those on tributary streams. The main stem sites generally have flatter gradients, greater capacity, and greater water supply. In planning the capacity of structures, attention to long-range needs is important. Usually it is less costly to provide capacity beyond immediate requirements in one-stage construction where otherwise a need will arise for early enlargement. Independent projects should be planned to fit into, complement, and not obstruct broad plans for ultimate river development.

The extensive hydroelectric power development on Bear River affects the relative economy of potential developments. Stream diversions in Cache Valley would adversely affect only the Cutler Powerplant which has a static head of 127 feet. A river diversion between the Cove and Oneida Powerplants to serve land in Cache or Malad Valley would affect both Oneida and Cutler Powerplants having a combined head of 272 feet. A diversion above Soda Powerplant would affect all five powerplants of the Utah Power & Light Company having a combined static head of about 975 feet.

Water Quality

In recent years much attention has been given nationally to the increasing problems of water pollution. Common causes of pollution are human, animal, and industrial wastes being discharged into the streams and salts leached from the soils and carried into streams in return flows from irrigation.

In conformance with the Federal Water Pollution Control Act, State water quality standards for the Bear River and its tributaries have been adopted by each of the three basin States. Each State's standards were approved by the Secretary of the Interior in 1968. Enforcement of these standards will help relieve existing pollution problems. The standards will also serve as guidelines in the planning of future developments.

CHAPTER V

POTENTIAL RECLAMATION DEVELOPMENT

Summary of Potentialities

Seven potentialities for water resource developments in the Bear River Basin, referred to as segments, are discussed in this chapter--one above Bear Lake and six below. Included in the discussion are three alternative plans for one of the segments and two for another. The plans are presented as being illustrative of the more favorable development potentialities in the various parts of the river basin. The projects described are not proposed as integral parts of a comprehensive basinwide development since they represent some overlapping and not all could be economically justified at this time.

A river basin development comprised of any practical combination of the plans discussed would not provide full control and utilization of the available water resources. The plans represent only a core for ultimate river development and could be added upon as further water conservation is justified. The scope and character of any future comprehensive development on Bear River will depend on water division agreements yet to be made by the basin States.

With few exceptions each of the seven segments would provide multiple purpose benefits for irrigation, recreation, flood control, and fish and wildlife. Three of them would also include water for municipal and industrial uses. Hydroelectric power developments were not found to be justified in any of the plans, mainly because most reservoir water would be released for irrigation, permitting only seasonal power generation at the dams. Favorable hydroelectric power sites in the Bear River Basin are largely developed. Several sites may be found suitable for pumped storage to provide peaking power, but only one such site, near Cutler Reservoir, has had cursory inspection.

All of the plans discussed in this report would operate independently of Bear Lake except for an infrequent and insignificant release of water from the lake for the Bennington Segment as later explained. Losses of power generation resulting from developments below Bear Lake would be recognized and settlements negotiated with owners of the powerplants. All other present water uses, whether based on water right, purchase, or other arrangement, would be fully provided for without added cost or change in time of delivery. All plans are based on continued administration of Bear River and its tributaries in accordance with the Bear River Compact and State water laws.

Scope of Investigations

Investigations of the seven segments have been made by the Bureau of Reclamation--some to feasibility standards and some to reconnaissance standards. Except where otherwise noted, recreational values of the projects and estimates of the cost of recreational facilities have been prepared by the National Park Service or the Bureau of Outdoor Recreation, fish and wildlife values have been estimated by the Bureau of Sport Fisheries and Wildlife, and flood control values by the Corps of Engineers.

An effort has been made to obtain reliable data for the analyses of the several segments. This applies to physical data, estimates of costs, benefits, water users' repayment ability, and other items. The Bureau of Reclamation and the cooperating agencies present their data as being subject to modifications that may be justified by changing economic conditions or more detailed investigations.

Costs

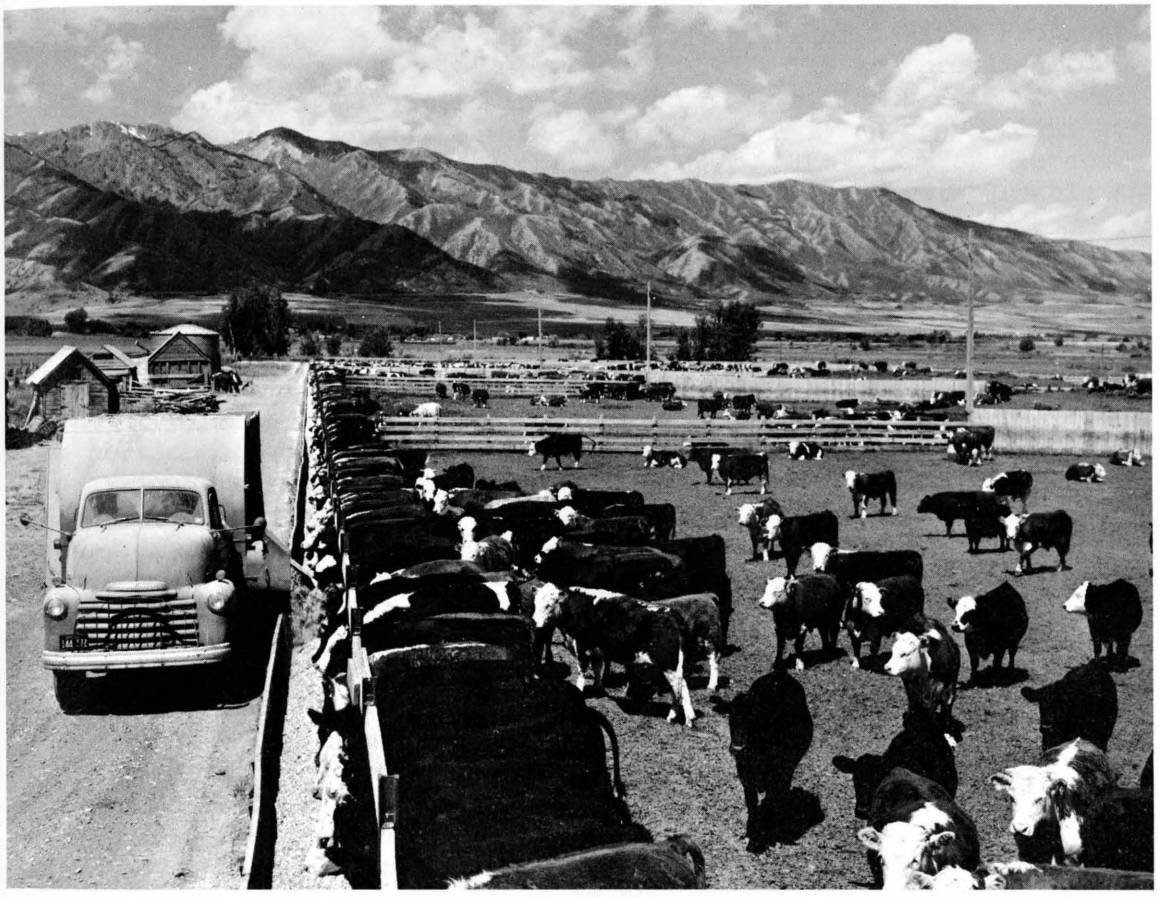
Construction costs were estimated at prices prevailing January 1969. Operation, maintenance, and replacement costs were based on average prices over a 3-year period from 1965 through 1967. It was assumed that electrical power for pumping would be obtained from the Bonneville Power Administration at its E-5 wholesale firm power rate. This rate, including wheeling to points of delivery, averages about 2.2 mills per kilowatt-hour. It includes a monthly demand charge of 95 cents per kilowatt and an energy charge of 1.25 mills per kilowatt-hour less an irrigation credit of 0.6 mill per kilowatt-hour.

An interest rate of 4 5/8 percent, which was applicable in the economic appraisal of Federal projects in fiscal year 1969, was used in computing costs of interest during construction. This rate was also used in estimating annual equivalent project costs and benefits used as a basis for the general economic appraisals made in this report.

Project Benefits

Benefits that would result from increased irrigation were estimated for conditions of an adequate water supply being fully available over a 100-year period. The estimates were based on agricultural conditions anticipated about 25 years after the first delivery of project water and reflect a trend toward improved farm production as a result of continuously improving farm techniques. Direct, indirect, and public benefits were estimated. Direct benefits are equal to the increase in net farm income. Indirect benefits include increased profits from retail and wholesale trade and processing and marketing of farm products that result from the increased irrigation. Public benefits are claimed for economic growth.

Benefits from project municipal and industrial water were assumed to be equal to the average annual equivalent cost of obtaining comparable water supplies from the most economical alternative single-purpose means of development. Flood control, recreation, and fish and wildlife benefits were estimated by cooperating Federal agencies, as mentioned previously.



Feed yard at E. A. Miller & Sons Packing Company plant at Hyrum, Utah.

Financial Appraisals

Allocations to project purposes have not been made of construction costs, interest during construction, and costs of operation, maintenance, and replacement. Probable allocations were considered, however, as a basis for general observations as to the extent to which reimbursable cost allocations could be paid.

Under existing laws and reclamation policy all project investment costs allocated to irrigation would be reimbursable in a 50-year period without interest. Costs allocated to municipal and industrial water would be reimbursable with interest in a 50-year period. The cost of water to municipal and industrial users would be set to accomplish the repayment.

Costs allocated to flood control would be nonreimbursable. Separate facilities for fish and wildlife and recreation, except those associated with national refuges, would be subject to the Federal Water Projects Recreation Act of July 9, 1965 (79 Stat. 213). The act provides for the inclusion of these facilities in Federal projects if non-Federal public bodies agree to administer the facilities and repay an appropriate portion of the costs allocated to these purposes. Thus part of the costs allocated to recreation and fish and wildlife would be reimbursable and part would be nonreimbursable.

The capacity of a farmer to pay for increased irrigation water supplies is considered to be the increased income remaining after he has paid his increased farm operating expense and is compensated for his increased labor, management, and capital investment. Only general determinations of payment capacity were made as a basis for the economic appraisals. The portion of the project construction cost that could not be repaid by the irrigators would be repaid from other revenue sources. Sources of assistance would need to be determined in the course of detailed planning of any development. The Columbia River Basin Account and the Upper Colorado River Basin Fund could be explored as possible sources of financial assistance.

Size of Farm

In a number of instances in the Bear River Basin acreages of irrigable land in individual ownerships are larger than could be provided water under reclamation law. The legal limitation is 160 acres in single ownership or 320 acres owned jointly by a man and wife. In some places these large ownerships are in nonirrigated areas where large farm units are required for economic operation. Under irrigation they could be divided into economic family-size units within the limits of reclamation law. Project participation by land owners would not be mandatory, however, so that the owners could withhold part or all of their lands from development if they preferred not to meet the acreage limitation. In places where climate and other factors limit crop production to the point where larger irrigated acreages are required for economic family farm units than permitted by the law, special legislation would be recommended. The intent would be to permit furnishing project water to larger acreages equivalent economically to farm units on more productive land that are within the acreage limitations of reclamation law.

Thomas Fork-Smiths Fork Segment

Segment purpose and plan

A dam and reservoir would be constructed on Thomas Fork as the only facilities required for the Thomas Fork-Smiths Fork Segment. Water stored in the reservoir would be released in the late irrigation season for supplemental irrigation of lands along Thomas Fork in Idaho and for replacement of part of the water now diverted from Bear River below the mouth of Thomas Fork. In exchange for the water reaching Bear River, water would be diverted higher on the river or from Smiths Fork which enters Bear River near Cokeville, Wyo., and used for supplemental irrigation in Wyoming. Existing ditches and canals are adequate to distribute the additional water. Most phases of the Thomas Fork-Smiths Fork Segment investigation were made in feasibility scope. The development plan is shown on the map on the following page.

In addition to irrigation, Thomas Fork Reservoir would have value for flood control and would provide recreational and fish and wildlife benefits. Although the reservoir would have no surcharge capacity for flood control, its active conservation capacity would be operated to meet flood control criteria proposed by the Corps of Engineers. Recreation facilities would be provided at the reservoir.

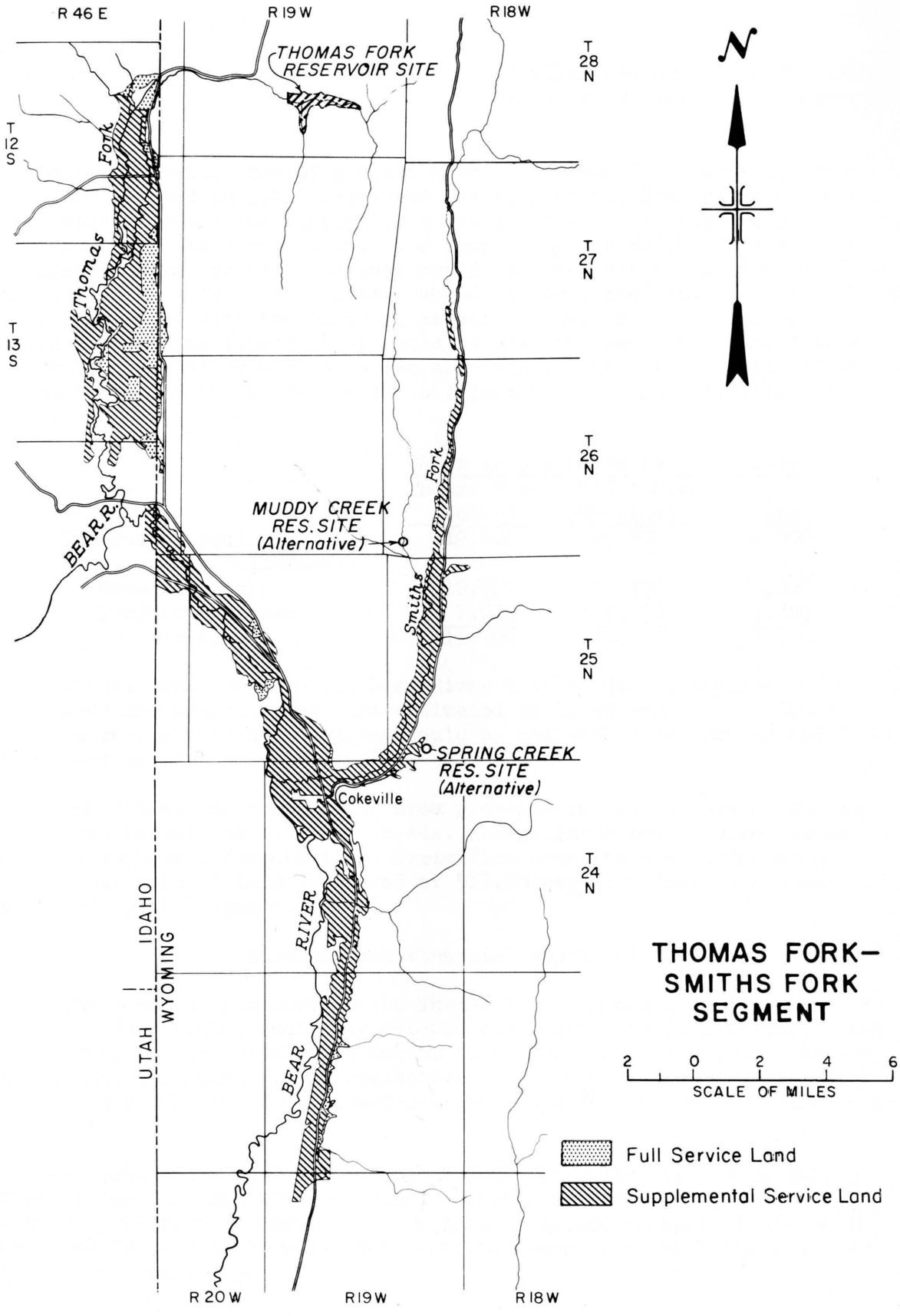
Thomas Fork Dam site is in Wyoming about 4 miles upstream from the point where the creek enters Idaho. The dam would be a rolled earth and rockfill structure 117 feet high and 710 feet long at its crest. The reservoir capacity would be 11,500 acre-feet, of which 9,500 acre-feet would be active.

Irrigation

Lands that would be irrigated are located from 6,000 to 6,900 feet above sea level. The annual frost-free period averages only about 37 days. A total of 21,700 acres of irrigated land could receive supplemental water from the reservoir although the water would probably be used on only part of these lands. The location and class of lands in the service area are shown below.

	Irrigated area (acres)		
Land class	Thomas Fork (Idaho)	Smiths Fork (Wyoming)	Total
Class 2	5,500	6,600	12,100
Class 3	2,600	7,000	9,600
Total	8,100	13,600	21,700

Existing irrigation water supplies for the lands, averaging 50,000 acre-feet annually, would be increased by 3,700 acre-feet annually under


R 46 E
R 19 W
R 18 W
THOMAS FORK RESERVOIR SITE
T 28 N
T 27 N
T 26 N
T 25 N
T 24 N
T 12 S
T 13 S
Thomas Fork
Bear R.
MUDDY CREEK RES. SITE (Alternative)
Smiths Fork
SPRING CREEK RES. SITE (Alternative)
Cokeville
IDAHO
WYOMING
UTAH
Bear River
R 20 W
R 19 W
R 18 W
N
THOMAS FORK–SMITHS FORK SEGMENT
2 0 2 4 6
SCALE OF MILES
Full Service Land
Supplemental Service Land

project operation. Use of project water on Thomas Fork lands in Idaho would be limited to 1,000 acre-feet annually by the Bear River Compact. With this increase the supply for these lands would average only about 60 percent of the requirement. The supply for the Smiths Fork area in Wyoming with the project increase would approach the irrigation requirement, leaving only shortages that would be considered tolerable in irrigation practice. With the holdover capacity provided in the reservoir a large part of the stored water could be used in years of greatest need and would thus alleviate the worst shortages. The water supply situation in each part of the project area is illustrated in the following tabulation.

	Water supply (acre-feet annually)		
	Thomas Fork (Idaho)	Smiths Fork (Wyoming)	Total
Diversion requirement	19,400	45,500	64,900
Water within requirement			
Present supply	10,700	39,300	50,000
Project increase	1,000	2,700	3,700
Total	11,700	42,000	53,700

Annual depletions to the Bear River from project operation, after allowance for return flows, are estimated at 1,850 acre-feet. About 1,350 acre-feet of the depletion would be chargeable to Wyoming and 500 acre-feet to Idaho.

The climate of the project area prevents intensive farming and limits crops largely to livestock feeds. Large farms are required to adequately support a farm family. Irrigation benefits are estimated at $33.80 per acre of land irrigated or $11.20 per acre-foot of new water provided by the segment.

Economic and financial appraisal

The construction cost of the Thomas Fork Dam and Reservoir is estimated at $4,446,000, including $46,000 for recreation facilities. Interest during construction would amount to an additional $206,000. Annual operation, maintenance, and replacement costs are estimated at $8,000, including $3,800 for the dam and reservoir and $4,200 for recreation facilities.

Project benefits would average $96,000 annually, including $42,000 from irrigation, $26,000 from flood control, $18,000 from fish and wildlife, $12,000 from recreation, and a loss of $2,000 to agriculture on lands required for rights-of-way. The benefits accruing in each State are shown on the following page.

Project purpose	Annual benefits		
	Idaho	Wyoming	Total
Irrigation			
Direct	$10,000	$26,000	$36,000
Indirect	2,000	4,000	6,000
Subtotal	12,000	30,000	42,000
Fish and wildlife		18,000	18,000
Recreation		12,000	12,000
Flood control	26,000		26,000
Gross benefits	38,000	60,000	98,000
Less agricultural benefits lost		2,000	2,000
Total benefits	38,000	58,000	96,000

Costs of the Thomas Fork-Smiths Fork Segment, if expressed as annual equivalent costs, would substantially exceed the annual benefits. If the costs were allocated among project purposes, the largest allocation of construction costs would be made to irrigation with substantial allocations to fish and wildlife and flood control and a smaller allocation to recreation. About half of the costs of operation, maintenance, and replacement would be incurred in connection with recreation facilities at the reservoir and would be allocated to recreation. The remaining half would be distributed among the other three purposes with slightly more being assigned to irrigation than to flood control or fish and wildlife.

Under reclamation law costs allocated to fish and wildlife and flood control would be nonreimbursable. The greater part of the construction costs and a small part of the operation and maintenance cost allocated to recreation would also be nonreimbursable. All costs allocated to irrigation would be reimbursable without interest.

The increase in net income to the farmers resulting from use of project water would be sufficient to pay the operation, maintenance, and replacement costs allocated to irrigation and a small part of the construction costs. A major part of the irrigation construction cost would need to be repaid from other revenue sources.

Alternative reservoir sites

Reservoir sites other than the Thomas Fork site have been considered for development in the Upper Bear River Valley. Although Wyoming's undeveloped storage allotment under the Bear River Compact is small (about 4,250 acre-feet), it is much larger than Idaho's allotment. This has an important bearing on the selection of storage sites.

Any reservoir development on the main stem of Smiths Fork was determined to have a greater cost than could be justified by the small amount

of storage required. Two sites on Smiths Fork tributaries that could be developed to store water for Wyoming lands appear to be worthy of further investigation.

The Muddy Creek Reservoir site is on Muddy Creek about 2 miles above the creek's junction with Smiths Fork. The junction in turn is about 8 miles northeast or upstream from Cokeville, Wyo. The site appears to be favorable topographically for a dam and a reservoir basin. A stream-gaging station operated over a 4-year period from October 1964 through September 1968 showed an average annual creek flow at the site of 3,800 acre-feet. About half of this flow occurs outside of the irrigation season and thus would be storable. Annual flows varied from 1,530 acre-feet in the water year ending September 1968 to 7,480 acre-feet in the year ending September 1965.

The Spring Creek site is just above Spring Creek's confluence with Smiths Fork at a point about 3 miles northeast of Cokeville. The site is physically attractive although the permeability of the dam abutments and reservoir basin would need to be explored. Spring Creek flows are fairly constant at about 4.5 second-feet, being derived from springs above the reservoir site. Excluding irrigation season flows which are already used, about 1,900 acre-feet of water annually would be storable. An estimated 2,000 acre-feet of additional water could be diverted to the reservoir from Pine Creek during the nonirrigation season through an existing ditch.

Bennington Segment

Segment purpose and plan

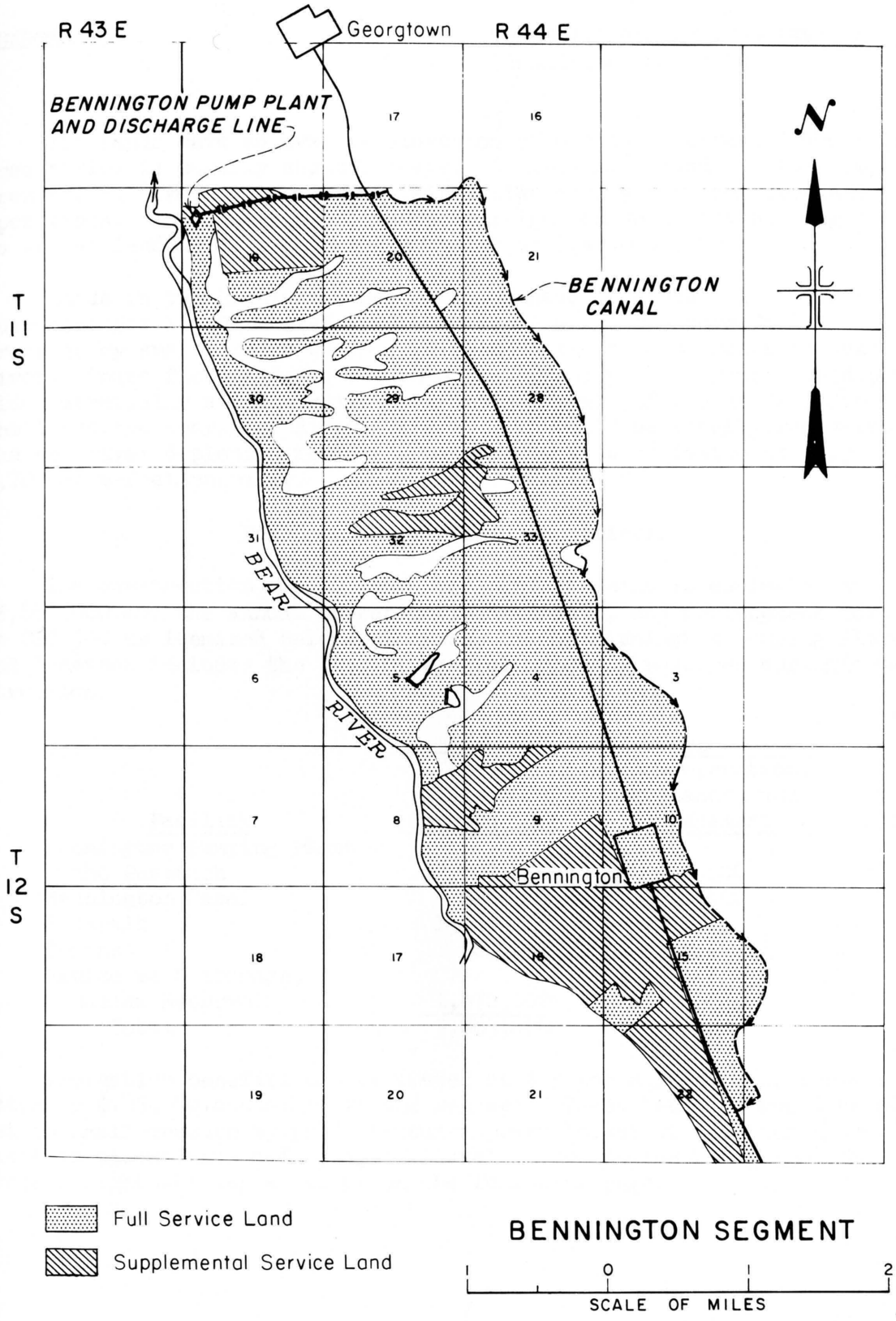
The Bennington Segment, as appraised in reconnaissance scope, would be a single-purpose development involving pumping of water from Bear River for the irrigation of Bear Lake Valley lands on the east side of the river in the vicinity of Bennington and Georgetown, Idaho. The Bennington Pumping Plant, located about 1½ miles southwest of Georgetown, would lift water 204 feet to the Bennington Canal which would extend southeast 7.2 miles, delivering water to 6,227 acres of land located between the canal and Bear River. The facilities and lands are shown on the map on the following page.

Since natural flows of Bear River at the pump site seldom exceed the requirements of downstream irrigation rights, water pumped from the river would have to be replaced by storage releases. It was assumed for the analysis that the water would be replaced from the potential Oneida Narrows Reservoir described later as a key feature of the Oneida Narrows Segment. Operation studies show that in about one-third of the years some water would need to be released from Bear Lake for the Bennington Segment for periods of a month or less. These periods would occur at times when no water is being released from the lake for irrigation below Oneida Narrows Reservoir and when river flows are insufficient for the Bennington Segment after allowance for downstream prior rights above Oneida Narrows Reservoir. The Bennington need for lake water would range from 400 to 3,300 acre-feet annually and would represent a drawdown of 0.6 inch or less at the lake. The water could be replaced in Bear Lake by exchange as soon as needs for lake water occur on lands below Oneida Narrows. Thus Bennington Segment releases from Bear Lake would not affect recreational values at the lake.

The Bennington Pumping Plant would have capacity to pump 121 second-feet. At peak operation it would require 3,800 kilowatts of power. The penstock would consist of 51-inch-diameter pretensioned concrete pipe, 8,000 feet in length. The Bennington Canal would have a capacity of 121 second-feet at its head. Laterals would be constructed for distribution of water to the land and drains would be provided as necessary.

Water would be provided to 4,972 acres that are not presently irrigated and 1,255 acres of irrigated land in need of supplemental water. The lands have been classified as class 2 or class 3 with acreage distribution as shown below.

	Area irrigated (acres)		
	Class 2	Class 3	Total
Full service (new) land	2,088	2,884	4,972
Supplemental service land	986	269	1,255
Total	3,074	3,153	6,227


R 43 E
Georgtown
R 44 E
BENNINGTON PUMP PLANT AND DISCHARGE LINE
BENNINGTON CANAL
T 11 S
T 12 S
BEAR RIVER
Bennington
Full Service Land
Supplemental Service Land
BENNINGTON SEGMENT
0
2
SCALE OF MILES

The lands have an average elevation of about 6,100 feet. The frost-free period is usually about 70 days. Nonirrigated lands in the project area are cultivated and produce fairly high crop yields for dry-farm operations. Thus added benefits from irrigation would not be as great as if the land were unproductive without irrigation.

Lands in the Bennington Segment area have an annual diversion requirement for 16,400 acre-feet of water. About 1,600 acre-feet is now provided by small creeks which flow through the area en route to Bear River. These flows and the 14,200 acre-feet of project water would provide essentially a full irrigation supply for all of the lands. Since the lands are near Bear River, return flows would be readily recovered. The net river depletion from project operation is estimated at only 6,700 acre-feet annually.

Economic and financial appraisal

The construction cost of the Bennington Segment is estimated at $5,883,000 and the annual operation, maintenance, and replacement costs at $28,500 as itemized below. The cost of the Bennington Pumping Plant and Penstock includes the cost of general property required during construction.

Facility	Estimated costs	
	Construction	Annual operation, maintenance, and replacement
Bennington Pumping Plant and Penstock	$2,503,000	$19,600
Bennington Canal	620,000	8,400
Laterals	1,090,000	
Drains	200,000	
Replacement storage, Oneida Reservoir	1,470,000	500
Total	5,883,000	28,500

Irrigation benefits are estimated at $13 per acre-foot of project water or $185,000 annually for the segment. These benefits would be offset in small measure by project-caused power losses at existing hydroelectric powerplants and by agricultural losses on lands required for project rights-of-way as shown on the following page.

Direct benefits	$158,000
Indirect benefits	27,000
Subtotal	185,000
Less benefits lost:	
Power	7,400
Agricultural	600
Subtotal	8,000
Total	177,000

The Bennington Segment could not be justified economically on the basis of the cost and benefit estimates shown above. The increased payment capacity of the farmers resulting from the additional water would about equal the cost of project operation, maintenance, and replacement, leaving no portion of their payments available to repay construction costs.

Caribou Segment

Segment purpose and plan

As planned from a reconnaissance investigation, the Caribou Segment would consist of the Caribou Reservoir on Bear River formed by a dam at a point about 2 miles south of Soda Springs, Idaho. Part of the reservoir water would be released to supplement the irrigation supply of the Last Chance Irrigation Company in the vicinity of Grace, Idaho. The remaining part would be used for municipal and industrial purposes to meet needs associated with an expanding phosphate-processing industry in the vicinity of Soda Springs. Municipal and industrial water would be made available at the river and the water users would provide their own facilities for diversion, conveyance, and treatment. The reservoir would also provide recreation and fish and wildlife benefits. Recreation facilities would be provided at the reservoir. The location of the reservoir and the lands that would be served are shown on the map on the following page.

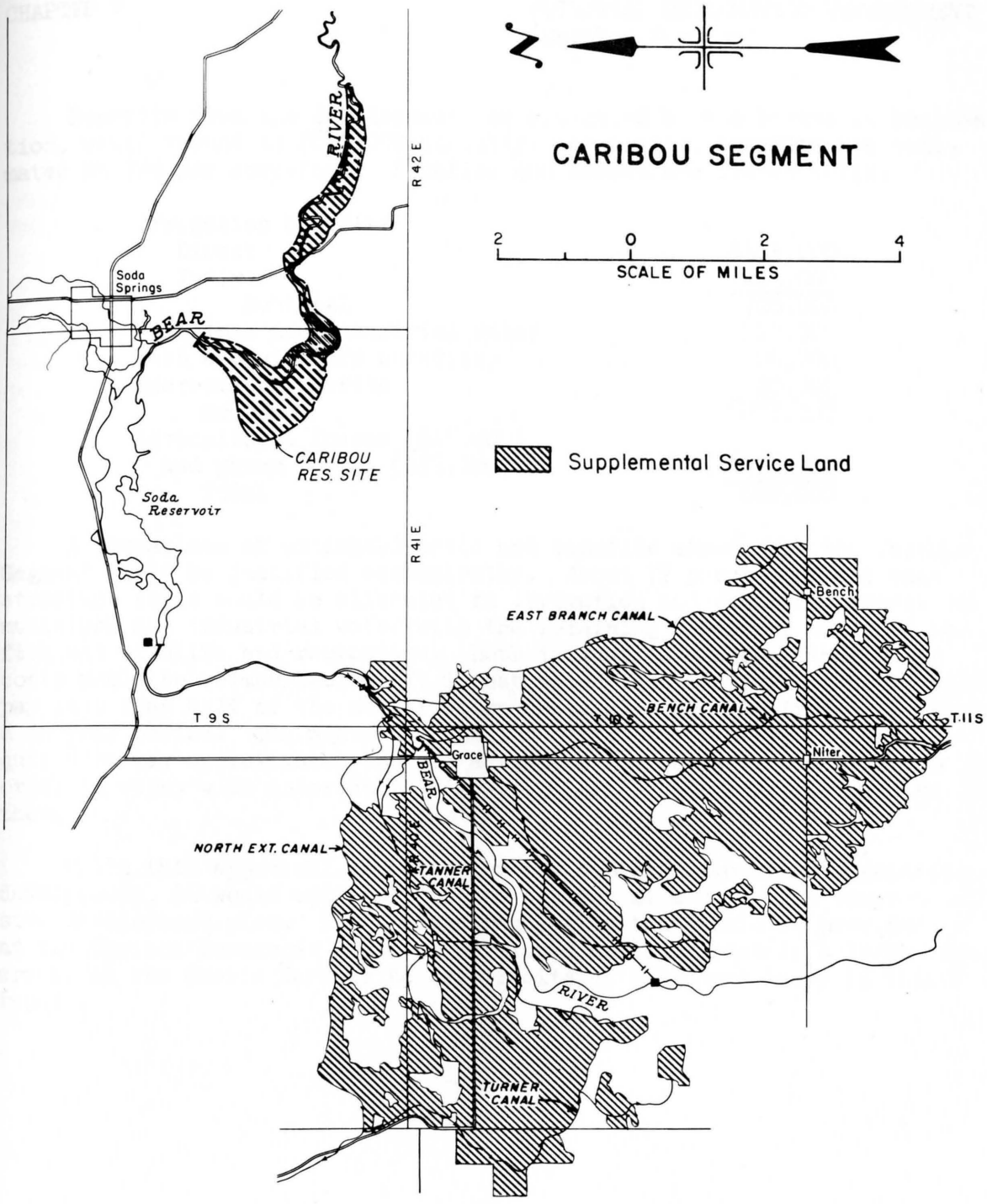
The Caribou Dam would be 76 feet high. The reservoir would have a capacity of 40,000 acre-feet, including 35,000 acre-feet of active capacity, 4,000 acre-feet for 100 years of sedimentation, and 1,000 acre-feet inactive. It would have a surface area of 2,230 acres but a total 3,700 acres of land would be required at the site for all project purposes. The project water yield would be about 35,000 acre-feet annually. It was assumed in the project analyses that 25,000 acre-feet would be used for irrigation and 10,000 acre-feet for municipal and industrial purposes. These quantities could be adjusted if found desirable in later studies.

Caribou Segment water would be used for supplemental irrigation of 28,000 acres of land, including 23,700 acres of class 1 land and 4,300 acres of class 2 land. These lands range in elevation from 5,550 to 5,700 feet above sea level in an area where the frost-free period averages about 98 days. The lands have an annual irrigation diversion requirement of 125,000 acre-feet. About 95,000 acre-feet of the requirement is met from present supplies and 25,000 acre-feet could be provided by the project, leaving only a nominal water shortage.

Operation of the Caribou Segment would deplete the flow of Bear River by an estimated 22,500 acre-feet annually.

Economic and financial appraisal

The construction cost of the Caribou Segment, including the dam and reservoir and recreation facilities, is estimated at $9,175,000. The estimated annual operation, maintenance, and replacement cost is $7,600, including $4,500 for the dam and reservoir and $3,100 for recreation facilities at the reservoir.


N
CARIBOU SEGMENT
2 0 2 4
SCALE OF MILES
Supplemental Service Land
RIVER
R 42 E
Soda Springs
BEAR
CARIBOU RES. SITE
Soda Reservoir
R 41 E
EAST BRANCH CANAL
Bench
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T 10 S
BENCH CANAL
T 11 S
Grace
Niter
BEAR
NORTH EXT. CANAL
TANNER CANAL
RIVER
TURNER CANAL

Benefits from the development, as estimated by the Bureau of Reclamation, would amount to $802,000 annually. Irrigation benefits are estimated at $28 per acre-foot. Benefits and losses are listed below.

Irrigation benefits	
Direct	$495,000
Indirect	213,000
Subtotal	708,000
Municipal and industrial water	110,000
Fish and wildlife benefits	20,000
Recreation benefits	20,000
Subtotal	858,000
Agricultural losses ($25,000) and power losses ($31,000)	56,000
Total	802,000

A comparison of estimated costs and benefits shows that the Caribou Segment would be justified economically. About 77 percent of the construction costs would be allocated to irrigation and about 16 percent to municipal and industrial water with the remaining 7 percent assigned to fish and wildlife and recreation. Both irrigation and municipal water costs would be reimbursable. It is estimated that the farmers could repay less than half of the construction costs allocated to irrigation in a 50-year period. The municipal and industrial water users would be required to pay approximately $8 per acre-foot for water at the river in order to repay with interest in a 50-year period the costs assigned to them.

While this appraisal is valid for the Caribou Segment as a separate development, it would not apply to the segment as a unit of a comprehensive development plan. The storage regulation that would be provided at the Caribou Reservoir could be developed at lower cost in a large reservoir at the Oneida Narrows Reservoir site as discussed later in this report.

Oneida Narrows Segment

Three alternative plans, each including an Oneida Narrows Reservoir on Bear River about 10 miles northeast of Preston, Idaho, are described on the following pages. Similar project service would be provided under each plan. In the first plan a large reservoir with 435,000 acre-feet of capacity would be constructed with the stored water distributed by gravity flow through the potential Oneida Canal and other canals for irrigation and other purposes in Cache and Malad Valleys. Water needs above the reservoir in Idaho would be served by exchange. The second plan is similar to the first except that water distribution would be accomplished by a number of short canals and pumping plants instead of by gravity flow through a long Oneida Canal. In the third plan a smaller Oneida Narrows Reservoir with a capacity of 140,000 acre-feet would be supplemented by reservoirs on Bear River at the Caribou site near Soda Springs, Idaho, and the Smithfield site near Smithfield, Utah. Water would be pumped from the smaller Oneida Narrows Reservoir to the Oneida Canal.

Oneida Narrows Dam and Reservoir site on Bear River.

Alternative Plan 1

Development Purposes

By means of storage regulation at the Oneida Narrows site, distribution works, and water exchanges, Alternative Plan 1 would increase the usable water supply of the main stem of Bear River. The water would be used for irrigation, municipal and industrial purposes, and fish and wildlife propagation. Benefits would also accrue to recreation and flood control.

Although some latitude could be used in the selection of lands to be irrigated, the plan was analyzed on the basis that 88,600 acres would be served, including 39,400 acres of full service land and 49,200 acres of supplemental service land distributed by States as shown below.

	(Unit--acres)		
	Idaho	Utah	Total
Full service land	15,200	24,200	39,400
Supplemental service land	46,500	2,700	49,200
Total	61,700	26,900	88,600

Irrigation supplies measured at points of diversion would be increased by an average of 177,200 acre-feet annually. Municipal and industrial water supplies, averaging 20,000 acre-feet annually, would be provided for use in the Soda Springs-Montpelier area of Idaho.

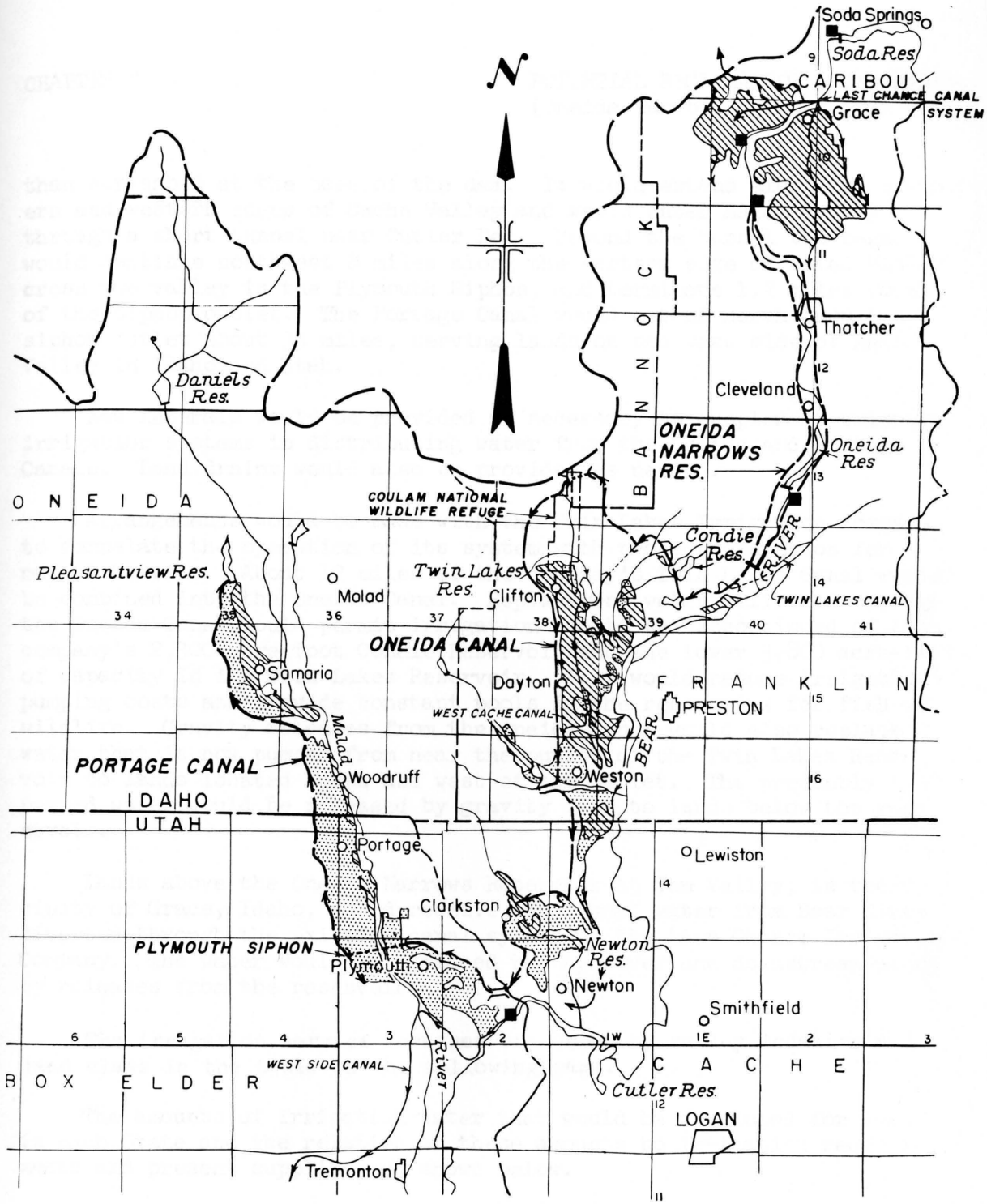
Irrigation use of the existing Condie Reservoir would be discontinued and a pool of 1,500 acre-feet would be maintained in the reservoir for fish habitat. Project water for fish and wildlife purposes would also be provided to two other existing reservoirs: Twin Lakes (3,800 acre-feet annually) and Newton (2,000 acre-feet annually). The potential Coulam National Wildlife Refuge near Oxford, Idaho, would receive 12,000 acre-feet annually.

Oneida Narrows Alternative Plan 1 is shown on the map on the following page.

Plan of Development

The plan of development, as formulated from investigations and analyses in feasibility scope, is described below by project purposes.

Irrigation.--The Oneida Narrows Reservoir with a capacity of 435,000 acre-feet would be formed by a dam 315 feet high. The reservoir would store water that enters the river below Bear Lake. The 75-mile-long Oneida Canal would head at the reservoir at a point 242 feet higher


Soda Springs
Soda Res.
CARIBOU
LAST CHANCE CANAL SYSTEM
Grace
Thatcher
Cleveland
Daniels Res.
BANNOCK
ONEIDA NARROWS RES.
Oneida Res
ONEIDA
COULAM NATIONAL WILDLIFE REFUGE
Condie Res.
RIVER
Pleasantview Res.
Malad
Twin Lakes Res.
Clifton
TWIN LAKES CANAL
ONEIDA CANAL
Samaria
Dayton
FRANKLIN
PRESTON
WEST CACHE CANAL
BEAR
PORTAGE CANAL
Malad
Woodruff
Weston
IDAHO
UTAH
Portage
Lewiston
Clarkston
PLYMOUTH SIPHON
Plymouth
Newton Res.
Newton
Smithfield
WEST SIDE CANAL
River
BOX ELDER
CACHE
Cutler Res.
LOGAN
Tremonton
Full Service Land
Supplemental Service Land
Existing Power Plant
ONEIDA NARROWS SEGMENT
ALTERNATIVE PLAN I
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SCALE OF MILES

than streambed at the base of the dam. It would extend along the northern and western edges of Cache Valley and would enter Malad Valley through a short tunnel near Cutler Dam. Beyond the tunnel the canal would continue northwest 8 miles along the eastern edge of Malad Valley, cross the valley in the Plymouth Siphon, and terminate 1.2 miles south of the siphon outlet. The Portage Canal would extend north from the siphon outlet about 33 miles, serving lands on the west side of Malad Valley in Idaho and Utah.

New laterals would be provided as necessary to supplement existing irrigation systems in distributing water from the Oneida and Portage Canals. Land drains would also be provided as needed.

Arrangements would be made with the Twin Lakes Irrigation Company to correlate the operation of its system with project operation for mutual benefit. About 12 miles of the company's Twin Lakes Canal would be combined into the Oneida Canal. Replacement water delivered through the Oneida Canal would permit irrigation use to be discontinued of the company's 2,300-acre-foot Condie Reservoir and the lower 3,800 acre-feet of capacity in its Twin Lakes Reservoir. This would reduce irrigation pumping costs and provide constant pools in the reservoirs for fish and wildlife. Gravity releases from the Oneida Canal would also replace water that is now pumped from near the outlet of the Twin Lakes Reservoir to lands located south and west of the outlet. The presently pumped water would be released by gravity flow to lands below the reservoir.

Lands above the Oneida Narrows Reservoir in Gem Valley, in the vicinity of Grace, Idaho, would receive additional water from Bear River diverted through the existing canal system of the Last Chance Irrigation Company. The water would be replaced to the river and downstream users by releases from the reservoir.

The irrigation service acreages are shown by valley location and land class in the table on the following page.

The amounts of irrigation water that would be developed for use in each State and the relation of these amounts to irrigation requirements and present supplies are shown below.

	Average annual water supplies (acre-feet)		
	Idaho	Utah	Total
Diversion requirement	227,400	94,600	322,000
Water within requirement			
Present supply	123,900	3,400	127,300
Developed by segment	89,600	87,600	177,200
Total	213,500	91,000	304,500

Irrigation service areas
Oneida Narrows Alternative Plan 1

Land location	Service area by land class (acres) Class 1	Class 2	Class 3	Total
Full service land				
Idaho				
Cache Valley	1,600	3,200	3,500	8,300
Malad Valley	2,100	3,100	1,700	6,900
Subtotal	3,700	6,300	5,200	15,200
Utah				
Cache Valley	2,200	2,600	1,200	6,000
Lower Bear River Valley	5,500	10,000	2,700	18,200
Subtotal	7,700	12,600	3,900	24,200
Supplemental service land				
Idaho				
Gem Valley	23,700	4,300		28,000
Cache Valley	6,700	7,300	1,600	15,600
Malad Valley	1,200	1,400	300	2,900
Subtotal	31,600	13,000	1,900	46,500
Utah				
Cache Valley	300	800	800	1,900
Lower Bear River Valley	300	400	100	800
Subtotal	600	1,200	900	2,700
Total segment--full and supplemental service	43,600	33,100	11,900	88,600

Fish, wildlife, and recreation.--Natural inflows would be sufficient to maintain storage of 1,500 acre-feet in Condie Reservoir for fishery purposes. Additional water would be pumped from the Oneida Canal to maintain freshness, and outflows would return to the canal. A 3,800-acre-foot minimum pool for fish would also be maintained at the Twin Lakes Reservoir as previously mentioned.

At the recommendation of the Bureau of Sport Fisheries and Wildlife, the Coulam National Wildlife Refuge would be established in Franklin County, Idaho, on 4,693 acres of land which includes Coulam Slough. About 12,000 acre-feet of project water annually would be released from the Oneida Canal into Deep Creek at the northern end of Cache Valley and allowed to flow southward to the refuge. The Oneida Canal would also convey 2,000 acre-feet of water annually to the existing Newton Reservoir in order to permit a minimum pool of 1,600 acre-feet to be maintained for fish. The new water would replace that in the pool in meeting irrigation demands and would also offset the evaporation and seepage losses from the fishery pool.

Twin Lakes Reservoir looking northwest. Coulam Slough in upper right of photo.

A minimum of 45 second-feet of water would be available below Oneida Narrows Dam for the downstream fishery except in infrequent years of extreme water shortage when fish flows would be reduced in proportion to shortages for irrigation.

Municipal and industrial water.--A firm supply of 20,000 acre-feet of water annually would be made available in Bear River to meet anticipated industrial and municipal requirements in the Soda Springs-Montpelier area above the Oneida Narrows Reservoir. This water is now largely used under rights below the reservoir but would be replaced to these rights by storage releases. The municipalities and industries would provide their own conveyance and treatment facilities as the exact locations of water use are determined. The water of local springs now used for irrigation may be used for municipal purposes and replaced to the irrigators from Bear River.

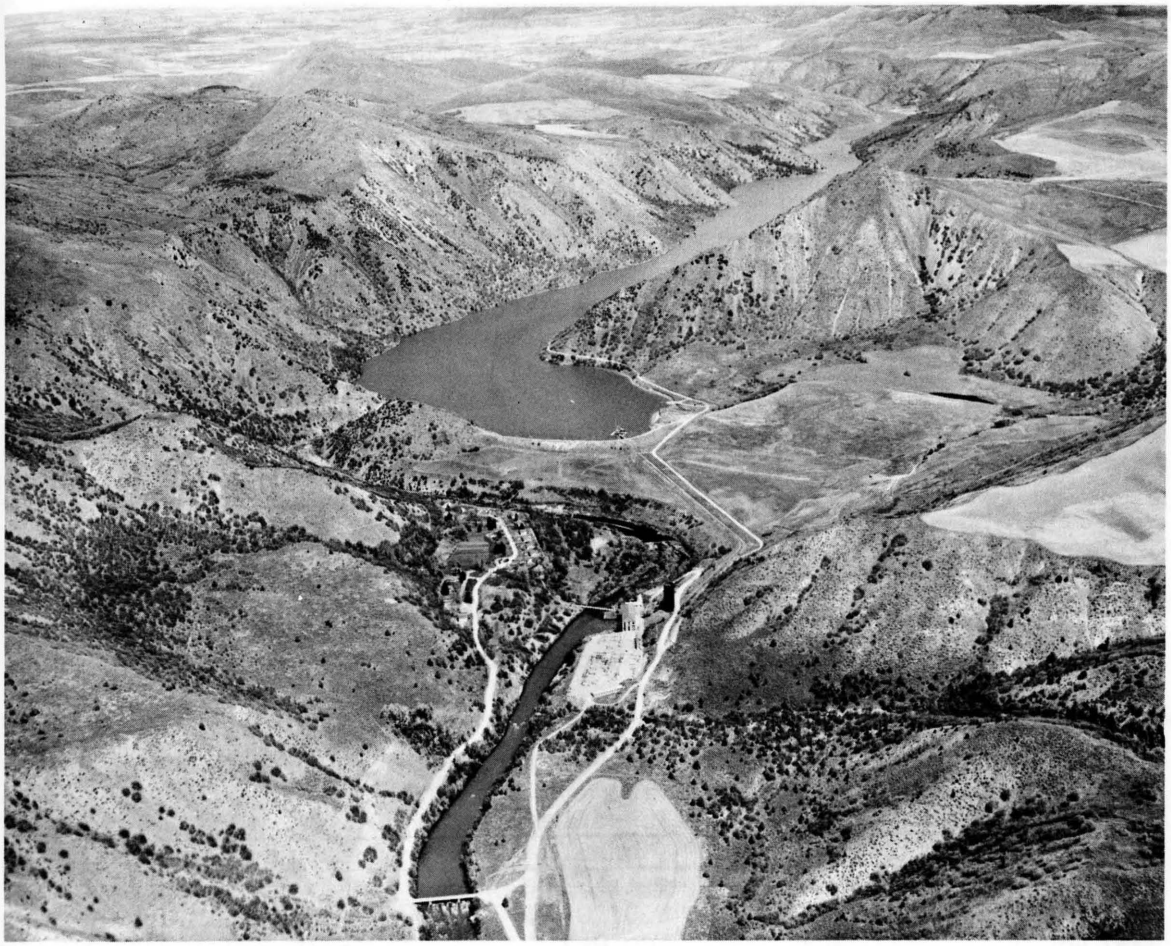
Flood control.--Operation of the Oneida Narrows Reservoir on the basis of streamflow forecasts would largely eliminate the flood damage which occurs along Bear River from the reservoir to Great Salt Lake.

River depletion.--The depletion to the flow of Bear River from the operation of Oneida Narrows Segment Plan 1 is estimated at 130,000 acre-feet annually. Of this amount about 82,500 acre-feet would result from uses in Idaho and 47,500 acre-feet from uses in Utah.

Construction Features

Oneida Narrows Dam would be an earth and rockfill structure built to a height of 315 feet above streambed. Its crest would be 30 feet wide and 1,252 feet long. The dam would contain 5,418,000 cubic yards of materials. The river outlet would be provided as would a canal outlet 242 feet above streambed. A controlled spillway would be located in the left abutment.

The Oneida Narrows Reservoir would extend upstream 32 river miles from the dam to the tailrace of the Cove Powerplant. Of its 435,000 acre-feet of capacity, 295,000 acre-feet would be active. Sediment is expected to occupy only 2,090 acre-feet of storage space in 100 years. At normal water surface elevation the reservoir would have a surface area of 9,400 acres. About 12,340 acres would be required as right-of-way for all purposes including construction, servicing, and recreation. The 30,000-kilowatt-capacity Oneida hydroelectric powerplant of the Utah Power & Light Company would be acquired as right-of-way along with a number of farmsteads, residences, and commericial properties.



Oneida Reservoir and Powerplant in Oneida Narrows Reservoir Basin.

The capacity of the 75-mile-long Oneida Canal would vary from 1,120 second-feet at its head to 360 second-feet at its terminus. Throughout its length the canal would traverse the terraces of ancient Lake Bonneville over the route previously described. The 33-mile-long Portage Canal would have an initial capacity of 330 second-feet and a terminal capacity of 25 second-feet. About 67 miles of new irrigation laterals would be required to supplement existing facilities in distributing water from the Oneida and Portage Canals. Drainage structures would be provided as needed.

Economic and Financial Appraisal

The construction of the Oneida Narrows Alternative Plan 1 is estimated at $80,092,000 and the annual operation, maintenance, and replacement cost at $185,000 as itemized on the following page. The cost of

the Oneida Narrows Dam and Reservoir includes the cost of temporary housing and other general property required during construction.

Facility	Estimated costs: Construction	Estimated costs: Annual operation, maintenance, and replacements
Oneida Narrows Dam and Reservoir	$31,990,000	$7,500
Oneida Canal	30,360,000	123,000
Portage Canal	7,470,000	27,700
Oneida Canal laterals	4,035,000	
Portage Canal laterals	2,635,000	
Oneida Canal drains	1,700,000	
Portage Canal drains	970,000	
Recreational facilities	292,000	26,800
Fish and wildlife facilities	640,000	
Total	80,092,000	185,000

Benefits from the Oneida Narrows Alternative Plan 1 are estimated at $6,228,000 annually. The major benefits would be from irrigation and are estimated at $33 per acre-foot of water. The benefits are itemized below by project purpose and the State in which they would occur.

Project purpose	Annual benefits: Idaho	Annual benefits: Utah	Annual benefits: Total
Irrigation			
Direct benefits	$2,401,000	$2,348,000	$4,749,000
Indirect benefits	538,000	526,000	1,064,000
Subtotal	2,939,000	2,874,000	5,813,000
Municipal and industrial	221,000		221,000
Fish and wildlife	220,000	34,000	254,000
Recreation	142,000	9,000	151,000
Flood control	31,000	31,000	62,000
Subtotal	3,553,000	2,948,000	6,501,000
Less agricultural losses	216,000	9,000	225,000
Subtotal	3,337,000	2,939,000	6,276,000
Less power losses			48,000
Total			6,228,000

Annual benefits of Alternative Plan 1 would be about 50 percent greater than annual equivalent costs. Thus development of the plan would be justified economically.

Approximately 87 percent of the construction costs would be allocated to irrigation and less than 4 percent to municipal and industrial water. It is estimated that the farmers could pay their allocated costs of

project operation, maintenance, and replacement, and in a 50-year period they could repay about 38 percent of the irrigation construction cost. In order to pay costs allocated to municipal and industrial water, the water users would be required to pay about $7.20 per acre-foot for water made available at the river. About 9 percent of the construction costs would be assigned to fish and wildlife, recreation, and flood control and would be largely nonreimbursable. Recreation interests, however, would be required to pay the cost of operation, maintenance, and replacement of recreation facilities at the Oneida Narrows Reservoir.

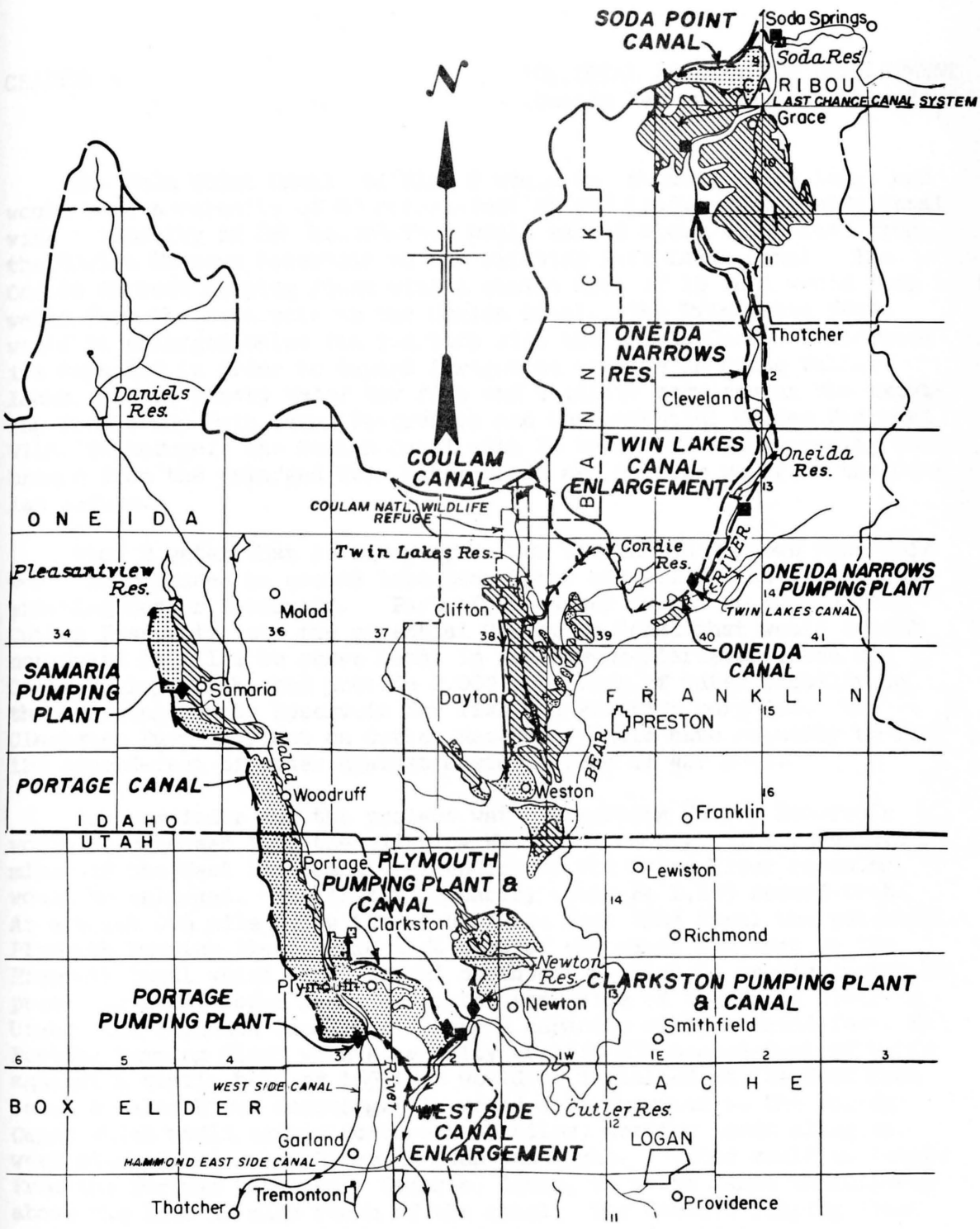
Alternative Plan 2

Purpose and Plan

The Oneida Narrows Alternative Plan 2 would be similar in purpose and size to Alternative Plan 1. In either plan the only new storage facility would be a 435,000-acre-foot capacity reservoir at the Oneida Narrows site. The principal difference is that the greater part of Plan 2 water, instead of being distributed by the 75-mile-long Oneida Canal of Plan 1, would be distributed by a number of shorter canals mostly served by pumping. The Plan 2 analyses were based on the information developed in feasibility scope for Plan 1. Modifications required for Plan 2, such as the substitution of a number of short canals and pumping plants, were investigated only in reconnaissance scope. A map of Alternative Plan 2 is on the following page.

Alternatives 1 and 2 would provide the same service and create the same benefits to municipal and industrial water, fish and wildlife, recreation, and flood control. These services are explained in the discussion of Plan 1.

The difference in distribution canals would cause some difference in the irrigated land areas between the two plans. The total area served under Plan 2 would be 85,500 acres or 3,100 acres less than under Plan 1. The greatest change would be in Gem Valley, Idaho, where under Plan 2 an additional 4,500 acres located north of the service area of the Last Chance Canal Company would be brought under irrigation through construction of the Soda Point Canal which would divert by gravity from Bear River at the existing Soda Reservoir. This new land, like other lands in the Grace area of Gem Valley is above the Oneida Narrows Reservoir site and would be served by exchange. Full irrigation service acreage reductions in Plan 2 over those of Plan 1 include 1,300 acres in Cache Valley, Idaho; 2,200 acres in Malad Valley, Idaho; 1,000 acres in Cache Valley, Utah; and 2,000 acres in Lower Bear River Valley, Utah. Supplemental irrigation service acreages would be the same in each segment except for a reduction of 1,100 acres under Plan 2 in Cache Valley, Idaho.


SODA POINT CANAL
Soda Springs
Soda Res.
CARIBOU
LAST CHANCE CANAL SYSTEM
Grace
ONEIDA NARROWS RES.
Thatcher
Cleveland
Daniels Res.
COULAM CANAL
TWIN LAKES CANAL ENLARGEMENT
Oneida Res.
COULAM NATL. WILDLIFE REFUGE
ONEIDA
Twin Lakes Res.
Condie Res.
Pleasantview Res.
Malad
Clifton
ONEIDA NARROWS PUMPING PLANT
TWIN LAKES CANAL
ONEIDA CANAL
SAMARIA PUMPING PLANT
Samaria
Dayton
FRANKLIN
PRESTON
PORTAGE CANAL
Woodruff
Weston
Franklin
IDAHO
UTAH
Portage
PLYMOUTH PUMPING PLANT & CANAL
Clarkston
Lewiston
Richmond
Newton Res.
CLARKSTON PUMPING PLANT & CANAL
PORTAGE PUMPING PLANT
Plymouth
Newton
Smithfield
WEST SIDE CANAL
BOX ELDER
WEST SIDE CANAL ENLARGEMENT
Cutler Res.
CACHE
Garland
LOGAN
HAMMOND EAST SIDE CANAL
Thatcher
Tremonton
Providence
Full Service Land
Supplemental Service Land
Existing Power Plant
ONEIDA NARROWS SEGMENT
ALTERNATIVE PLAN II
10 0 10
SCALE OF MILES

The Soda Point Canal of Plan 2 would be about 7 miles long and would have a capacity of 80 second-feet at its head. The Oneida Canal with a capacity of 260 second-feet would extend about 6,000 feet from the Oneida Narrows Reservoir to the existing Twin Lakes Canal. The Oneida Narrows Pumping Plant with a static head of 19 feet would pump water from the reservoir to the Oneida Canal. The Twin Lakes Canal would be enlarged below its junction with the Oneida Canal to increase its capacity in order to expand irrigation service in Cache Valley, Idaho, and to convey water for fish and wildlife services at the existing Condie and Twin Lakes Reservoirs and the potential Coulam National Wildlife Refuge. The Coulam Canal with 70 second-feet of capacity would branch from the enlarged Twin Lakes Canal and deliver water to the Coulam Refuge.

Plan 2 water that is not pumped from the Oneida Narrows Reservoir would be released as needed into Bear River and allowed to flow to the existing Cutler Reservoir. Part of the water would be pumped from Cutler Reservoir into the potential Clarkston Canal that would extend northward 11 miles to serve lands in the Newton-Clarkston area of Cache Valley, Utah, and provide 2,000 acre-feet of water annually to the existing Newton Reservoir for fish and wildlife purposes. The Clarkston Pumping Plant on Cutler Reservoir would have capacity to lift 120 second-feet of water against a static head of 422 feet.

The remainder of the project water reaching Cutler Reservoir would be released into the existing West Side Canal. The upper 8.5 miles of the West Side Canal, extending to the Malad River crossing, would be enlarged. The initial capacity would be 1,155 second-feet. At a point 0.6 mile below the head of the West Side Canal the potential Plymouth Pumping Plant would lift part of the water 220 feet to the Plymouth Canal which would extend northwest 9 miles to provide water for presently undeveloped lands along the east side of the Malad River in Utah. The Plymouth Canal would have a capacity of 150 second-feet. The Portage Pumping Plant with a capacity to lift 250 second-feet of water against a static head of 165 feet would be installed at the West Side Canal's Malad River crossing. It would deliver water to the Portage Canal which would extend northwest 35 miles, serving lands along the west side of the Malad River in Utah and Idaho. Water would be pumped from the Portage Canal near Samaria, Idaho, to serve lands immediately above the last 12-mile reach of the canal. The Samaria Pumping Plant would have a capacity of 45 second-feet and would operate under a static head of 235 feet. The irrigable acreage by location and land class is shown on the following page.

Irrigation service areas, Oneida Narrows Alternative Plan 2

Land location	Service area by land class (acres) Class 1	Class 2	Class 3	Total
Full service land				
Idaho				
Gem Valley	3,600	900		4,500
Cache Valley	3,100	3,000	900	7,000
Malad Valley	900	2,700	1,100	4,700
Subtotal	7,600	6,600	2,000	16,200
Utah				
Cache Valley	2,100	2,600	300	5,000
Lower Bear River Valley	5,600	7,700	2,900	16,200
Subtotal	7,700	10,300	3,200	21,200
Supplemental service land				
Idaho				
Gem Valley	23,700	4,300		28,000
Cache Valley	6,300	6,500	1,700	14,500
Malad Valley	900	1,800	200	2,900
Subtotal	30,900	12,600	1,900	45,400
Utah				
Cache Valley	200	300	1,400	1,900
Lower Bear River Valley	400	300	100	800
Subtotal	600	600	1,500	2,700
Total segment--full and supplemental service land	46,800	30,100	8,600	85,500

The amounts of irrigation water that would be developed for use in each State and the relation of these amounts to irrigation requirements and present supplies are shown below.

	Average annual water supplies (acre-feet) Idaho	Utah	Total
Diversion requirement	231,000	84,000	315,000
Water within requirement			
Present supply	128,800	1,700	130,500
Developed by segment	91,200	78,300	169,500
Total	220,000	80,000	300,000

The depletion to the flow of Bear River from the operation of Oneida Narrows Alternative Plan 2 is estimated at 124,000 acre-feet annually. About 77,000 acre-feet of the depletion would pertain to water use in Idaho and 47,000 acre-feet to use in Utah.

Economic and Financial Appraisal

The construction cost of Oneida Narrows Alternative Plan 2 is estimated at $80,877,000 and the annual operation, maintenance, and

replacement cost at $256,000 as itemized below. The cost of the Oneida Narrows Dam and Reservoir includes the cost of temporary housing and other general property required during construction.

Facility	Estimated costs: Construction	Estimated costs: Annual operation, maintenance, and replacement
Oneida Narrows Dam and Reservoir	$32,765,000	$7,800
Pumping plants		
Oneida Narrows	890,000	3,200
Clarkston	3,160,000	42,400
Plymouth	1,650,000	38,200
Portage	3,960,000	43,300
Samaria	860,000	13,100
Canals		
Soda Point	850,000	10,500
Oneida	870,000	300
Twin Lakes (enlargement)	6,230,000	16,500
Coulam	780,000	1,600
Clarkston	1,570,000	9,300
Plymouth	1,320,000	13,500
West Side	9,250,000	2,100
Portage	6,300,000	27,400
Laterals (by canal service areas)		
Soda Point	625,000	
Twin Lakes	1,600,000	
Clarkston	1,065,000	
Plymouth	1,610,000	
Portage	2,450,000	
Drains (by canal service areas)		
Soda Point	90,000	
Twin Lakes	565,000	
Clarkston	575,000	
Plymouth	390,000	
Portage	960,000	
Recreational development	292,000	26,800
Fish and wildlife facilities	640,000	
Total	80,877,000	256,000

Benefits from Oneida Narrows Plan 2, estimated in the same manner as the benefits from Plan 1, would be $5,988,000 annually. The benefits are itemized on the following page by project purpose and the State in which they would occur.

Project purpose	Annual benefits		
	Idaho	Utah	Total
Irrigation			
Direct benefits	$2,444,000	$2,098,000	$4,542,000
Indirect benefits	547,000	470,000	1,017,000
Subtotal	2,991,000	2,568,000	5,559,000
Municipal and industrial	221,000	0	221,000
Fish and wildlife	220,000	34,000	254,000
Recreation	142,000	9,000	151,000
Flood control	31,000	31,000	62,000
Subtotal	3,605,000	2,642,000	6,247,000
Less agricultural losses	210,000	5,000	215,000
Subtotal	3,395,000	2,637,000	6,032,000
Less power losses			44,000
Total			5,988,000

Annual benefits of Alternative Plan 2 would be about 40 percent greater than annual equivalent costs. As in Plan 1 approximately 87 percent of the construction cost would be allocated to irrigation and less than 4 percent to municipal and industrial water use. Operation, maintenance, and replacement costs would be higher than in Plan 1 because of the greater pumping requirement. The irrigators would be able to pay these costs, however, and in a 50-year period repay about 29 percent of the irrigation construction costs. Municipal water made available at the river would be sold at about $7 an acre-foot in order to repay costs allocated to that use in a 50-year period. About 9 percent of the construction cost would be assigned to fish and wildlife, recreation, and flood control and would be largely nonreimbursable. Recreation interests, however, would be required to pay the cost of operation, maintenance, and replacement of recreation facilities at Oneida Narrows Reservoir.

Alternative Plan 3

Purposes and Plan

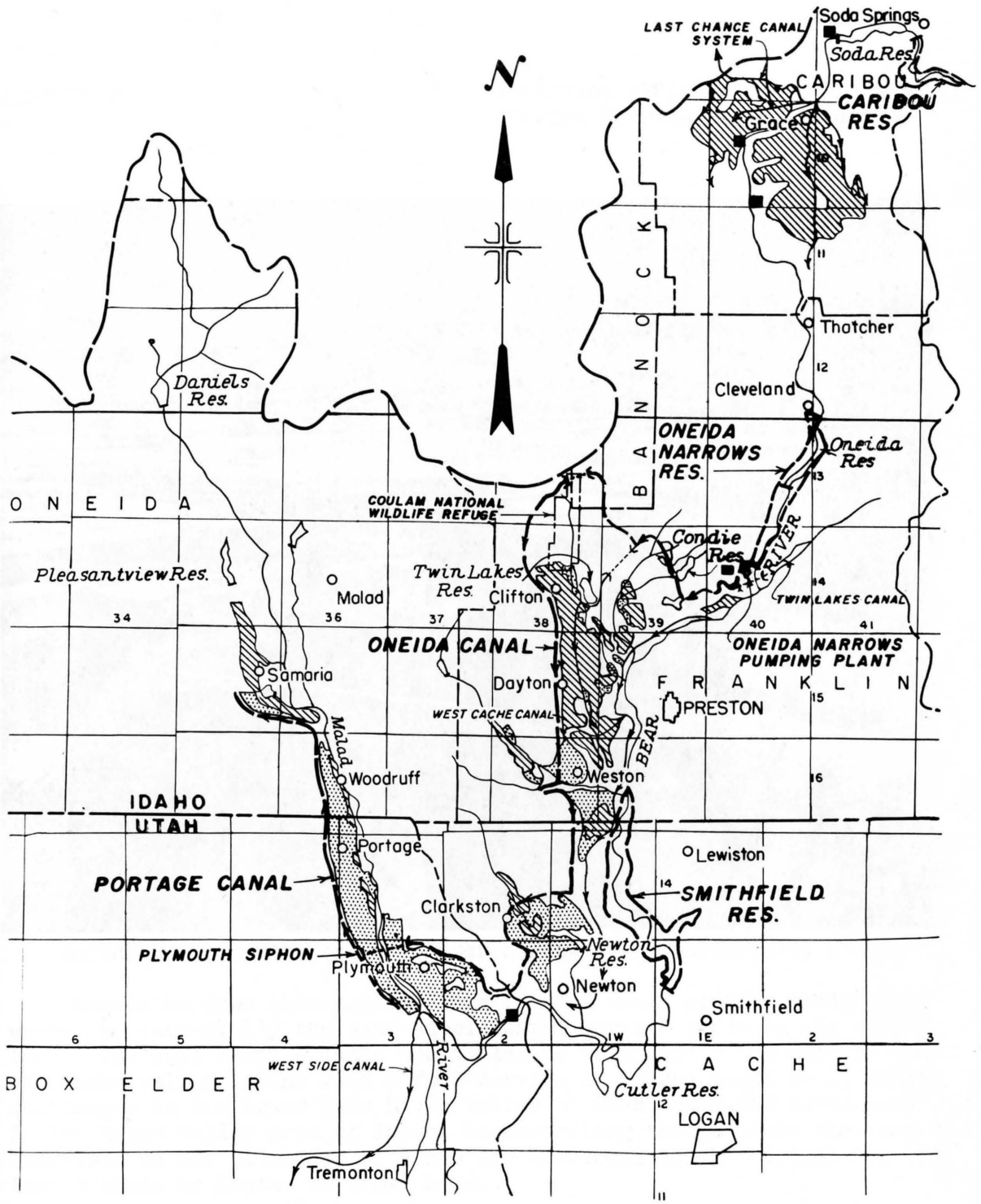
The Oneida Narrows Alternative Plan 3 differs from Alternative Plan 1 mainly in the location and capacity of reservoirs on Bear River. The Oneida Narrows Reservoir would be smaller than in the first plan and would be supplemented by reservoirs at the Caribou and Smithfield sites. The smaller Oneida Narrows Reservoir, formed by a dam 265 feet high, would have a capacity of 140,000 acre-feet, of which 120,000 acre-feet would be active. The smaller reservoir would be confined to the canyon section of the river and would not encroach upon agricultural land. It would be necessary to pump from the smaller reservoir to the Oneida Canal. The plan has been investigated in reconnaissance scope except that detailed information obtained in other investigations was utilized where applicable. A map of Plan 3 is on the following page.

The Caribou Reservoir in the Oneida Narrows Alternative Plan 3 would be the same in location, size, and purpose as the reservoir in the Caribou Segment previously described. Its operation would be correlated, however, with operation of the other two reservoirs of Plan 3.

The Smithfield Reservoir would be formed by a dam 51 feet high on Bear River northwest of Smithfield, Utah. It would have a capacity of 70,000 acre-feet, of which 58,000 acre-feet would be active, 10,000 acre-feet reserved for 100 years of sedimentation, and 2,000 acre-feet inactive. An additional surcharge capacity of 30,000 acre-feet would be provided for flood control and to effect a cost saving by reducing the required capacity of the spillway. The reservoir surface area would be 5,610 acres, but about 9,600 acres of land would be required at the site for all project purposes. Located below all diversions from Bear River included in this plan, Smithfield Reservoir would perform an exchange function in storing water for existing downstream rights so that part of the water otherwise required for these rights could be diverted into the Oneida Canal at the Oneida Narrows Reservoir.

The Oneida Canal of Alternative Plan 3 would be on the same alinement as in Oneida Narrows Alternative Plan 1 and would have essentially the same capacity. The canal would terminate about 3.4 miles south of the Plymouth Siphon outlet. The Portage Canal extending north from the siphon outlet would be smaller and shorter than in Plan 1 because of a reduced service area and would be constructed at a lower and less costly location. The canal would be 18 miles long and would have a capacity of 230 second-feet at its head.

The Oneida Narrows Pumping Plant would lift water from the reservoir to the Oneida Canal. The lift would range from 10 to 135 feet, depending on the level of water in the reservoir. The pumping plant would have a capacity of 1,110 second-feet and a peak demand of 20,000 kilowatts.


LAST CHANCE CANAL SYSTEM
Soda Springs
Soda Res.
CARIBOU
CARIBOU RES.
Grace
Thatcher
Cleveland
Daniels Res.
BANNOCK
ONEIDA NARROWS RES.
Oneida Res
ONEIDA
COULAM NATIONAL WILDLIFE REFUGE
Condie Res.
LEVAN
TWIN LAKES CANAL
Pleasantview Res.
Malad
Twin Lakes Res.
Clifton
ONEIDA CANAL
ONEIDA NARROWS PUMPING PLANT
Samaria
Dayton
FRANKLIN
PRESTON
WEST CACHE CANAL
BEAR
Malad
Woodruff
Weston
IDAHO
UTAH
Portage
Lewiston
PORTAGE CANAL
SMITHFIELD RES.
Clarkston
PLYMOUTH SIPHON
Plymouth
Newton Res.
Newton
Smithfield
WEST SIDE CANAL
River
CACHE
BOX ELDER
Cutler Res.
LOGAN
Tremonton
Full Service Land
Supplemental Service Land
Existing Power Plant
ONEIDA NARROWS SEGMENT
ALTERNATIVE PLAN III
10 0 10
SCALE OF MILES

Smithfield Dam site on Bear River northwest of Smithfield, Utah.

Oneida Narrows Alternative Plans 1 and 3 would provide irrigation water for essentially the same supplemental service lands in all valleys. The full service lands would also be essentially the same in Gem and Cache Valleys. The Plan 3 full service land area would be 2,200 acres larger in the Lower Bear River Valley of Utah and 3,600 acres smaller in the Malad Valley area of Idaho, demonstrating the latitude that may be exercised in the selection of lands for development. The distribution of Plan 3 lands by States is shown below.

	Unit--acres		
	Idaho	Utah	Total
Full service land	11,600	26,400	38,000
Supplemental service land	46,500	2,700	49,200
Total	58,100	29,100	87,200

A further breakdown of the irrigation service areas by location and land class is shown on the following page.

Irrigation service areas, Oneida Narrows Alternative Plan 3

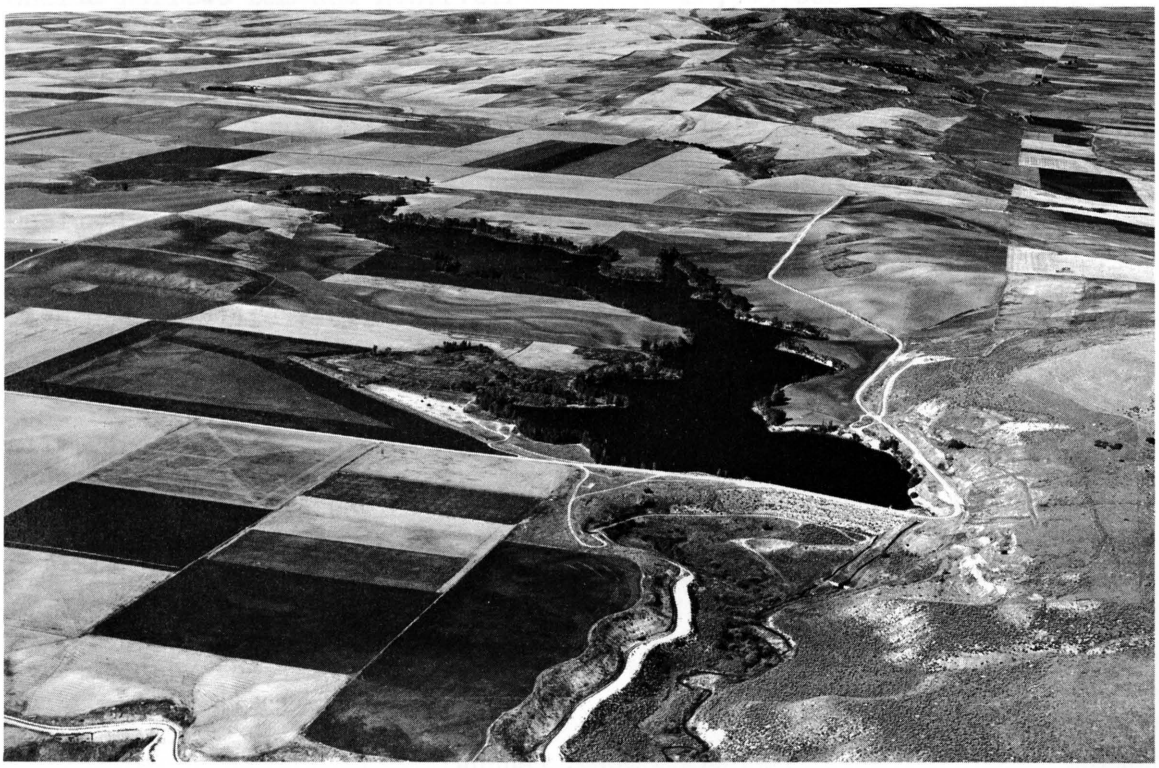
Land location	Service area by land class (acres) Class 1	Class 2	Class 3	Total
Full service land				
Idaho				
Cache Valley	1,600	3,200	3,500	8,300
Malad Valley	900	1,700	700	3,300
Subtotal	2,500	4,900	4,200	11,600
Utah				
Cache Valley	2,200	2,600	1,200	6,000
Lower Bear River Valley	7,600	6,300	6,500	20,400
Subtotal	9,800	8,900	7,700	26,400
Supplemental service land				
Idaho				
Gem Valley	23,700	4,300		28,000
Cache Valley	6,700	7,300	1,600	15,600
Malad Valley	1,200	1,400	300	2,900
Subtotal	31,600	13,000	1,900	46,500
Utah				
Cache Valley	300	800	800	1,900
Lower Bear River Valley	400	300	100	800
Subtotal	700	1,100	900	2,700
Total area--full and supplemental service	44,600	27,900	14,700	87,200

The amounts of irrigation water that would be developed for use in each State by Oneida Narrows Alternative Plan 3 and the relation of these amounts to irrigation requirements and present supplies are shown below.

	Average annual water supplies (acre-feet) Idaho	Utah	Total
Diversion requirement	214,600	103,000	317,600
Water supply within requirement			
Present supply	114,400	13,900	128,300
Developed by segment	75,100	96,100	171,200
Total	189,500	110,000	299,500

Oneida Narrows Plans 1 and 3 would both make available in Bear River 20,000 acre-feet of water annually for anticipated municipal and industrial water needs in the Soda Springs-Montpelier area. Recreation benefits are evaluated as equal under the two plans with the high benefits at the large Oneida Narrows Reservoir of Plan 1 being equal to those of the three smaller reservoirs of Plan 3. Fish and wildlife facilities and operations at the proposed Coulam National Wildlife Refuge and at the modified Condie, Twin Lakes, and Newton Reservoirs would be the same for each

plan. Fish and wildlife benefits at the large Oneida Narrows Reservoir of Plan 1, however, would be greater than those of the three smaller reservoirs of Plan 3. Flood control benefits of Plan 1 would be about double those of Plan 3.



The Newton Reservoir fishery would be improved by the Oneida Narrows Segment.

The depletion to the flow of Bear River from the operation of Oneida Narrows Alternative Plan 3 is estimated at 132,000 acre-feet annually. About 75,000 acre-feet of the depletion would be chargeable to Idaho and 57,000 acre-feet to Utah.

Economic and Financial Appraisal

The construction cost of the Oneida Narrows Alternative Plan 3 is estimated at $102,497,000 and the annual operation, maintenance, and replacement cost at $328,000. The costs are itemized on the following page. The cost of the Oneida Narrows Dam and Reservoir includes the cost of temporary housing and other general property required during construction.

Facility	Estimated costs	
	Construction	Annual operation, maintenance, and replacement
Caribou Dam and Reservoir	$8,190,000	$4,500
Oneida Narrows Dam and Reservoir	21,545,000	4,200
Smithfield Dam and Reservoir	24,070,000	8,200
Oneida Narrows Pumping Plant	6,530,000	148,500
Oneida Canal	30,360,000	123,000
Portage Canal	1,710,000	12,800
Oneida Canal laterals	4,450,000	
Portage Canal laterals	2,070,000	
Oneida Canal drains	1,740,000	
Portage Canal drains	840,000	
Recreation facilities	292,000	26,800
Fish and wildlife facilities	700,000	
Total	102,497,000	328,000

Benefits from Oneida Narrows Plan 3, estimated at $5,889,000 annually, are itemized in the table below. Irrigation and municipal and industrial water benefits were estimated by the Bureau of Reclamation. Irrigation benefits would amount to $33 per acre-foot of water provided by the plan. The Bureau also estimated recreation and fish and wildlife benefits from estimates made by the National Park Service and the Bureau of Sport Fisheries and Wildlife for Oneida Narrows Plan 1. Flood control benefits estimated by the Corps of Engineers for Oneida Narrows Plan 1 were used by the Bureau of Reclamation as a base for estimating flood control benefits for Plan 3.

Project purpose	Annual benefits		
	Idaho	Utah	Total
Irrigation			
Direct benefits	$2,013,000	$2,576,000	$4,589,000
Indirect benefits	451,000	577,000	1,028,000
Subtotal	2,464,000	3,153,000	5,617,000
Municipal and industrial	221,000		221,000
Fish and wildlife	131,000	60,000	191,000
Recreation	142,000	9,000	151,000
Flood control	15,000	15,000	30,000
Subtotal	2,973,000	3,237,000	6,210,000
Less agricultural losses	100,000	172,000	272,000
Subtotal	2,873,000	3,065,000	5,938,000
Less power losses			49,000
Total			5,889,000

Annual benefits of Alternative Plan 3 would approximate the annual equivalent costs on the basis of the preceding estimates, showing the plan to have marginal economic justification. If costs were allocated

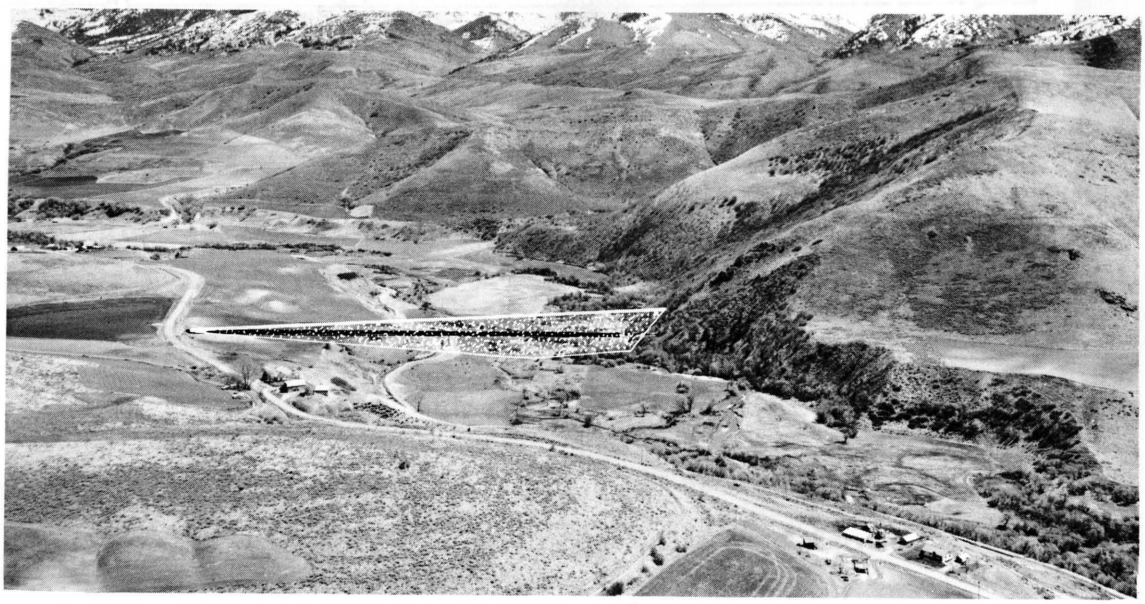
to project purposes, approximately 90 percent of the construction cost and 85 percent of the operation, maintenance, and replacement costs would be assigned to irrigation. After paying their operation, maintenance, and replacement costs, the irrigators could probably repay about 19 percent of their allocated construction costs without interest in a 50-year period. About 3 percent of the construction cost would be allocable to municipal and industrial water. Users of this water would need to pay about $8.20 an acre-foot for the water at the river in order to pay their portion of the operation, maintenance, and replacement cost and repay their assigned construction costs with interest in a 50-year period. The remaining 7 percent of the construction cost would be allocated to fish and wildlife, recreation, and flood control, and the greater part would be nonreimbursable. Recreation interests would be required to pay operation, maintenance, and replacement costs on recreational facilities.

East Cache Segment

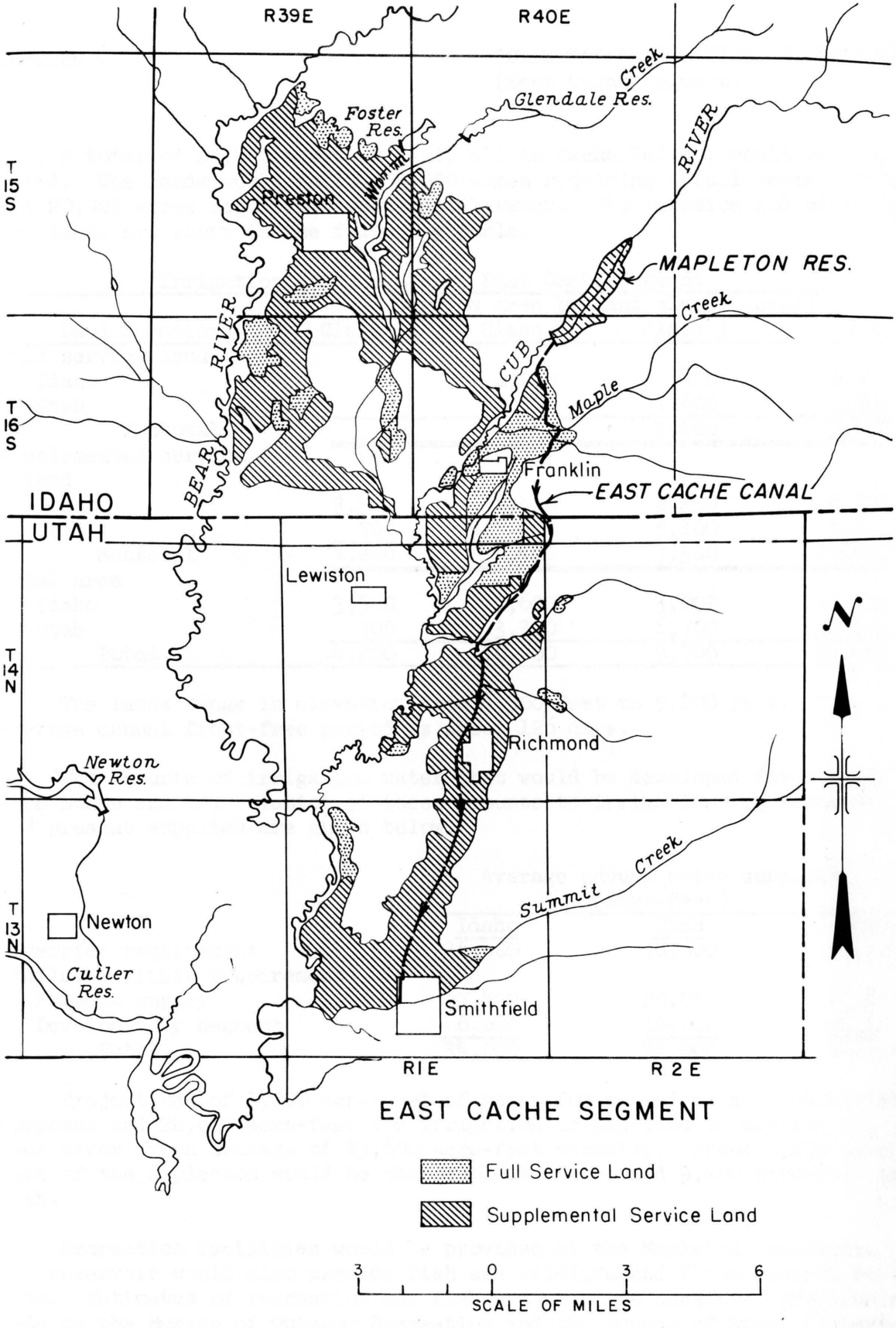
Purpose and plan

The East Cache Segment, which has been investigated in feasibility scope, would develop flows of Cub River, a Bear River tributary, primarily for irrigation and municipal and industrial service in northeastern Cache Valley in Idaho and Utah. The project would also provide flood control, recreation, and fish and wildlife benefits.

Project works would consist of the Mapleton Dam and Reservoir on Cub River about 3 miles northeast of Franklin, Idaho, and the East Cache Canal extending south 19 miles from the dam to Summit Creek near Smithfield, Utah. The dam would be an earth and rockfill structure 160 feet high with a crest length of 1,940 feet. The reservoir would have a capacity of 34,486 acre-feet, of which 32,702 acre-feet would be active. The canal would convey irrigation water to existing irrigation systems. Project laterals would be provided as necessary to convey water to lands not presently irrigated, and land drains would be constructed where needed. The canal would also convey 1,000 acre-feet of water annually to meet increased municipal and industrial needs at Lewiston and Smithfield, Utah. The municipalities would likely arrange to release the water for irrigation and in exchange divert additional spring water into their municipal systems. A map of the segment appears on the following page.



Mapleton Dam Site on Cub River.


R39E
R40E
T 15 S
T 16 S
T 14 N
T 13 N
R1E
R2E
Foster Res.
Glendale Res.
Creek
RIVER
Preston
North Fk
MAPLETON RES.
Creek
BEAR RIVER
CUB
Maple
Franklin
EAST CACHE CANAL
IDAHO
UTAH
Lewiston
Richmond
Newton Res.
Summit Creek
Newton
Cutler Res.
Smithfield
N
EAST CACHE SEGMENT
Full Service Land
Supplemental Service Land
3 0 3 6
SCALE OF MILES

A total of 24,800 acres of land, all in Cache Valley, would be irrigated. The lands would include 3,900 acres requiring a full water supply and 20,900 acres requiring supplemental water. The location and class of the lands are shown in the following table.

Irrigation service areas, East Cache Segment

Land location	Service area by land class (acres) Class 1	Class 2	Class 3	Total
Full service land				
Idaho		1,200	800	2,000
Utah		300	1,600	1,900
Subtotal		1,500	2,400	3,900
Supplemental service land				
Idaho	3,500	6,400	2,200	12,100
Utah	700	3,000	5,100	8,800
Subtotal	4,200	9,400	7,300	20,900
Total area				
Idaho	3,500	7,600	3,000	14,100
Utah	700	3,300	6,700	10,700
Total	4,200	10,900	9,700	24,800

The lands range in elevation from 4,500 feet to 5,200 feet. The average annual frost-free period is about 126 days.

The amounts of irrigation water that would be developed for use in each State and the relation of these amounts to irrigation requirements and present supplies are shown below.

	Average annual water supplies (acre-feet) Idaho	Utah	Total
Diversion requirement	36,400	38,600	75,000
Available within requirement			
Present supply	27,400	20,000	47,400
Developed by segment	6,600	16,000	22,600
Total	34,000	36,000	70,000

Project use of 1,000 acre-feet of water for municipal and industrial purposes and 22,600 acre-feet for irrigation is expected to deplete the Bear River by an average of 13,600 acre-feet annually. About 4,200 acre-feet of the depletion would be chargeable to Idaho and 9,400 acre-feet to Utah.

Recreation facilities would be provided at the Mapleton Reservoir. The reservoir would also provide fish and wildlife and flood control benefits. Estimates of recreation and fish and wildlife benefits, previously made by the Bureau of Outdoor Recreation and the Bureau of Sport Fisheries

and Wildlife, were brought up to date by the Bureau of Reclamation. Flood control benefits were estimated by the Corps of Engineers.

Economic and financial appraisal

The construction cost of the East Cache Segment is estimated at $16,563,000 and the annual operation, maintenance, and replacement cost at $28,000. The costs are itemized below. The cost of the Mapleton Dam and Reservoir includes the cost of general property required during construction.

	Estimated cost	
Facility	Construction	Annual operation, maintenance, and replacement
Mapleton Dam and Reservoir	$11,993,000	$5,000
East Cache Canal	3,220,000	16,000
Laterals	300,000	
Drains	990,000	
Recreation facilities	60,000	7,000
Total	16,563,000	28,000

Annual benefits from the East Cache Segment are estimated at $967,000. Irrigation benefits are estimated at $40 per acre-foot of water. The benefits are itemized below by purpose and the State in which they would occur.

	Annual benefits		
Project purpose	Idaho	Utah	Total
Irrigation			
Direct benefits	$213,000	$517,000	$730,000
Indirect benefits	52,000	127,000	179,000
Subtotal	265,000	644,000	909,000
Municipal and industrial		13,000	13,000
Fish and wildlife	27,000		27,000
Recreation	15,000		15,000
Flood control	0	21,000	21,000
Subtotal	307,000	678,000	985,000
Less agricultural losses	12,000	4,000	16,000
Subtotal	295,000	674,000	969,000
Less power losses			2,000
Total			967,000

The preceding estimates of costs and benefits indicate that the East Cache Segment would be economically justified with annual benefits exceeding annual equivalent costs. About 91 percent of the project construction costs would be allocable to irrigation and about 2 percent to municipal

and industrial water. The irrigators could pay their operation, maintenance, and replacement costs and in a 50-year period could repay about 20 percent of their portion of the construction costs. In order for municipal and industrial water users to pay their allocated costs, a charge of about $16.50 would be necessary for water at the East Cache Canal. The 7 percent of the costs allocated to fish and wildlife, recreation, and flood control would be nonreimbursable although recreation interests would be required to operate and maintain project recreation facilities.

Blacksmith Fork Segment

Two alternative plans are reported in reconnaissance scope for the Blacksmith Fork Segment that would develop water of Blacksmith Fork, a tributary of Logan River. The two streams join in Cache Valley south of Logan, Utah, and flow thence in the valley to Little Bear River, which discharges into Cutler Reservoir on Bear River. A basic difference between the alternative plans is that they involve different storage sites on Blacksmith Fork. The first plan includes development of the Mill Creek Reservoir site which is located on Blacksmith Fork about 14 miles upstream from the mouth of Blacksmith Fork Canyon near Hyrum, Utah. In the second plan storage would be provided at the Forks Reservoir site about 3 miles above the mouth of the canyon. Relocation of the existing road would be made at either site. Streamflows are greater at the Forks site than at the Mill Creek site, and thus a larger development could be made with a greater conservation of water. Both plans have been investigated in reconnaissance detail. A map of the segment showing both alternative sites appears on the following page.

Alternative Plan 1

Purpose and Plan

The Blacksmith Fork Alternative Plan 1 would develop flows of Blacksmith Fork for irrigation, municipal, and industrial use in southeastern Cache Valley in Utah. The segment would also provide flood control, recreation, and fish and wildlife benefits. Project water would be regulated at the Mill Creek Reservoir which would be formed by a dam on Blacksmith Fork about 2 miles upstream from the Hardware Ranch Wildlife Management Unit. The stored water would be released into Blacksmith Fork and allowed to flow to the Blacksmith Fork Diversion Dam near the mouth of the canyon where it would be diverted into the potential Providence Bench Canal which would extend northward 10 miles to the Logan River. The canal would deliver water into existing irrigation facilities. About 2,000 acre-feet of the water would replace water that is being used for irrigation, permitting it to be used by exchange for municipal and industrial purposes in communities along the canal route.

Recreation facilities would be provided at Mill Creek Reservoir. Fish and wildlife benefits would be provided at the reservoir and existing values would be maintained in the stream below the reservoir. The reservoir operation would also reduce downstream flood damage.

The Mill Creek Dam would be 125 feet high and 860 feet long at its crest. The reservoir would have a capacity of 10,000 acre-feet, of which 8,250 acre-feet would be active. The Providence Bench Canal would have a capacity of 55 second-feet at its head.

R.1E R.2E R.3E R.4E

T.12 N

T.11 N

T.10 N

U.S. 89

LOGAN

River Heights

RIVER

LOGAN

U.S. 91

Providence

Millville

PROVIDENCE BENCH CANAL

Hyrum

HYRUM RES.

LITTLE BEAR RIVER

Paradise

FORKS RESERVOIR SITE
(ALTERNATIVE PLAN NO. 2)

Left Fork

Bear Hollow

Saddle Creek

Creek

Rock

BLACKSMITH FORK

Curtis Creek

Gate Canyon

Devils Canyon

South Cottonwood

MILL CREEK RESERVOIR SITE
(ALTERNATIVE PLAN NO. 1)

Dry Gulch

Mollens Hollow

Mill Cr.

LEGEND

Full Service Land

Supplemental Service Land

0 1 2

SCALE OF MILES

BLACKSMITH FORK SEGMENT

Mill Creek Dam and Reservoir Site on Blacksmith Fork.

Lands that would receive water range from 4,500 to 4,800 feet in elevation. The frost-free period averages about 161 days. A total of 2,000 acres would be irrigated with land classes and type of irrigation services as shown in the following table.

Irrigation service, Blacksmith Fork Alternative Plan 1

Type of service	Service area by land class (acres)			
	Class 1	Class 2	Class 3	Total
Full irrigation service	5	136	984	1,125
Supplemental service	55	217	603	875
Total	60	353	1,587	2,000

The irrigation water diversion requirement of the project area is estimated at 10,300 acre-feet annually, of which about 2,400 acre-feet is presently available. Alternative Plan 1 would develop an additional 7,700 acre-feet for irrigation, increasing the total supply to 10,100 acre-feet. The additional irrigation and the 2,000 acre-feet annually

provided for municipal and industrial use would cause Bear River flows to be depleted by an average of 4,600 acre-feet annually, all of it chargeable to uses in Utah.

Economic and Financial Appraisal

The construction cost of Plan 1 is estimated at $7,962,000 and the annual operation, maintenance, and replacement cost at $14,500. The costs are itemized below.

Facility	Estimated cost	
	Construction	Annual operation, maintenance, and replacement
Mill Creek Dam and Reservoir	$6,640,000	$4,000
Blacksmith Fork Diversion Dam	115,000	
Providence Bench Canal	1,130,000	7,500
Recreation facilities	75,000	3,000
General property	2,000	
Total	7,962,000	14,500

Benefits from the Blacksmith Fork Alternative Plan 1 are estimated at $344,000 annually. Irrigation benefits are estimated at $25 per acre-foot of water. Benefits from the various purposes are listed below.

Irrigation	
Direct benefit	$154,000
Indirect benefit	36,000
Subtotal	190,000
Fish and wildlife	27,000
Recreation	18,000
Flood control	3,000
Municipal and industrial	113,000
Subtotal	351,000
Less loss of agricultural benefits on rights-of-way	7,000
Total	344,000

Costs of Blacksmith Fork Alternative Plan 1, if reduced to annual equivalents, would be slightly less than the annual benefits on the basis of the estimates previously presented. This would indicate that the project would be marginal economically although a future analysis made under different benefit and cost criteria may show it to be favorable.

An allocation of construction costs to project purposes would result in about the following distribution: irrigation, 56 percent; municipal and industrial water, 28 percent; fish and wildlife, 10 percent; recreation, 5 percent; and flood control, 1 percent. The estimated payment

ability of the irrigators would be sufficient to pay operation, maintenance, and replacement costs assigned to irrigation and in a 50-year period about 16 percent of the irrigation construction costs. Users of municipal and industrial water would be required to pay about $60 per acre-foot for water at the Providence Bench Canal in order to meet operation, maintenance, and replacement costs and repay their allocated construction costs in a 50-year period.

Construction costs assigned to fish and wildlife, recreation, and flood control would be largely nonreimbursable. Recreation facilities would be operated and maintained by non-Federal interests.

Alternative Plan 2

Purpose and Plan

With a larger reservoir on Blacksmith Fork than Plan 1 and a greater water supply, Blacksmith Fork Alternative Plan 2 would provide all of the irrigation and municipal water service of Plan 1 and in addition would provide 25,000 acre-feet of water annually for other uses. It was assumed in the project analysis that this 25,000 acre-feet of water would be released into Bear River as needed for downstream uses. If desired, the water could also be moved upstream on the river system by exchange. It was further assumed that this water would be distributed to 6,200 acres of presently unirrigated class 2 land. The value of Blacksmith Fork Plan 2 benefits to fish and wildlife and recreation would be comparable to those of Plan 1. Flood control benefits would be substantially greater in Plan 2 because of the larger reservoir located lower on the stream channel.

The Forks Dam would be about 230 feet high and 1,030 feet long at its crest. The reservoir capacity would be 47,000 acre-feet, of which about 42,000 acre-feet would be active. Recreation facilities would be provided at the reservoir. The Providence Bench Canal would be the same as in Plan 1. It would deliver 7,700 acre-feet of water annually for irrigation of 2,000 acres of land and in addition would provide 2,000 acre-feet of water for municipal use by exchange, all as in Plan 1.

In summary, Plan 2 would provide 7,700 acre-feet of water annually for irrigation in the Providence Bench area, 25,000 acre-feet for irrigation elsewhere in the Bear River service area, and 2,000 acre-feet for municipal and industrial use. Operation of Plan 2 would deplete Bear River flows by an average of 17,000 acre-feet annually.

Forks Reservoir Site on Blacksmith Fork.

Economic and Financial Appraisal

The construction cost of the Blacksmith Fork Alternative Plan 2 is estimated at $29,737,000 and the annual operation, maintenance, and replacement costs at $31,000. The costs are itemized on the following page.

Facility	Estimated cost: Construction	Estimated cost: Annual operation, maintenance, and replacement
Forks Dam and Reservoir	$22,670,000	$5,000
Blacksmith Fork Diversion Dam	115,000	
Providence Bench Canal	1,130,000	7,500
Diversion and conveyance facilities for water released to Bear River (assumed cost)	5,720,000	13,500
Recreation facilities	100,000	5,000
General property	2,000	
Total	29,737,000	31,000

Benefits from Plan 2 are estimated at $1,212,000 annually. Benefits by purposes are listed below.

Irrigation	
Direct benefit	$824,000
Indirect benefit	186,000
Subtotal	1,010,000
Fish and wildlife	75,000
Recreation	20,000
Flood control	8,000
Municipal and industrial	113,000
Subtotal	1,226,000
Less loss of agricultural benefits on rights-of-way	14,000
Total	1,212,000

Costs of Plan 2, converted to annual equivalent costs, would be about 20 percent lower than the annual benefits on the basis of the reconnaissance grade estimates shown above.

Under present cost allocation procedures construction costs of Plan 2 would be allocated to project purposes in approximately these proportions: irrigation, 80 percent; municipal and industrial water, 11 percent; fish and wildlife, 7 percent; recreation, 1 percent; and flood control, 1 percent. Payments by the irrigators would be enough to pay their costs of operation, maintenance, and replacement and in a 50-year period to repay about 20 percent of the irrigation construction cost allocation. In order to provide revenue to meet municipal and industrial water costs, the water would need to be sold for about $90 an acre-foot at the Providence Bench Canal. Construction costs allocated to fish and wildlife and flood control would be nonreimbursable as would the greater part of the cost allocated to recreation. Recreation interests would be required to pay operation, maintenance, and replacement costs allocated to recreation.

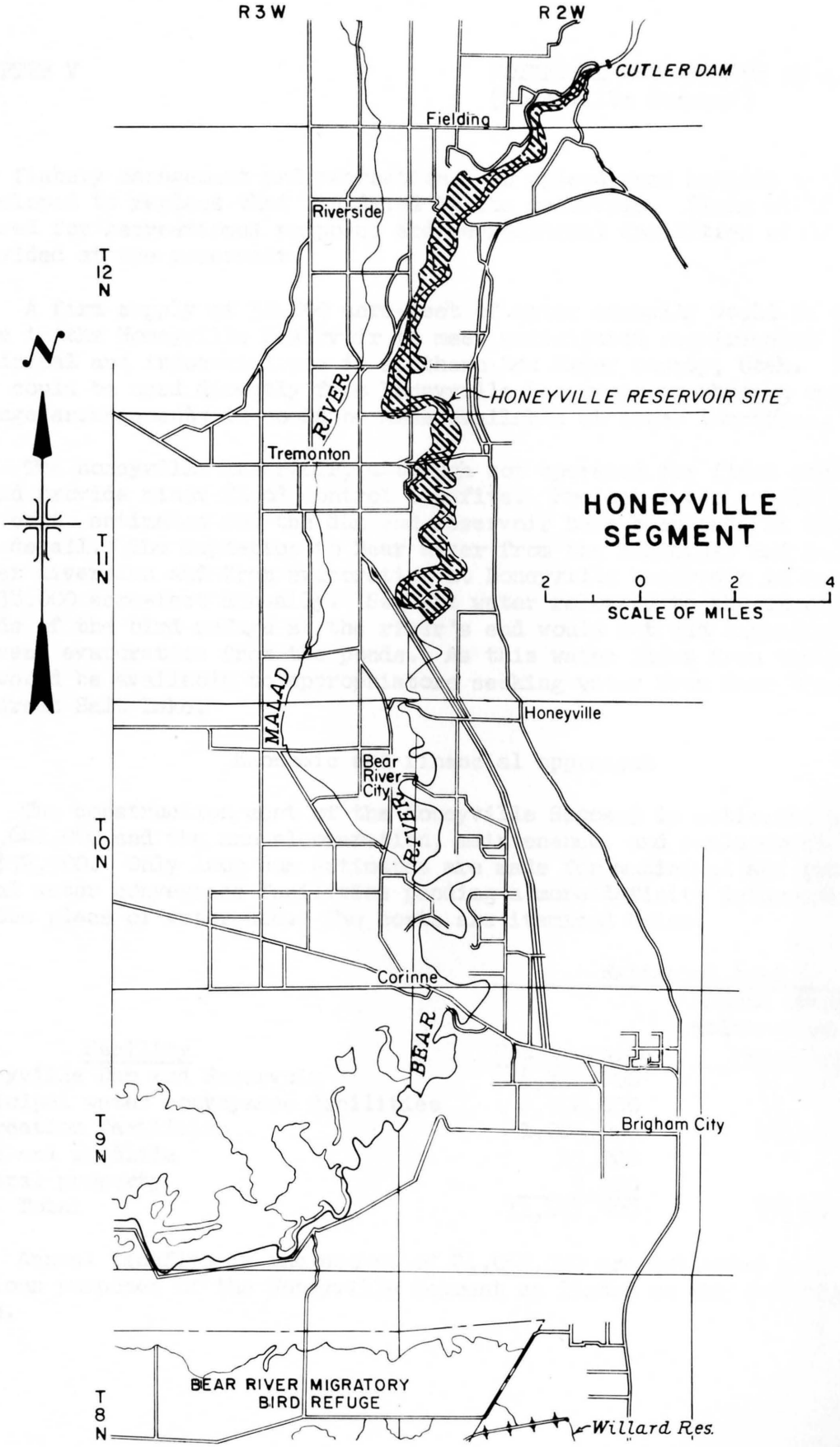
Honeyville Segment

Segment plan and purpose

The Honeyville Reservoir on Bear River, formed by a dam at a point about 4 miles southeast of Tremonton, Utah, and 15 miles north of Bear River Bay of Great Salt Lake, would be the principal feature of the Honeyville Segment. The dam would be 76 feet high and the reservoir would have a capacity of 120,000 acre-feet, of which 105,000 acre-feet would be active. A map of the segment is on the following page.

Honeyville Dam Site on Bear River.

An annual average of 68,000 acre-feet of water would be released from Honeyville Reservoir and would flow in Bear River to the Bear River Migratory Bird Refuge. The water would supplement natural river flows in meeting the seasonal needs of the refuge. A minimum river flow of 50 second-feet would be maintained below the reservoir for fish. A permanent pool of 15,200 acre-feet would be maintained in Honeyville Reservoir


R3W
R2W
CUTLER DAM
Fielding
Riverside
T12N
HONEYVILLE RESERVOIR SITE
RIVER
Tremonton
HONEYVILLE
SEGMENT
2 0 2 4
SCALE OF MILES
T11N
MALAD
Honeyville
Bear
River
City
RIVER
T10N
Corinne
BEAR
Brigham City
T9N
BEAR RIVER MIGRATORY
BIRD REFUGE
T8N
Willard Res.

for fishery management and recreation. An upland game habitat would be developed to replace that inundated by the reservoir. Lands would be acquired for recreational purposes and recreational facilities would be provided at the reservoir.

A firm supply of 30,000 acre-feet of water annually would be available in the Honeyville Reservoir to meet anticipated requirements for municipal and industrial use in southern Box Elder County, Utah. The water could be used directly from Honeyville Reservoir or through water exchange arrangements it could be made available at other locations.

The Honeyville Reservoir, although not operated for flood control, would provide minor flood control benefits. Project water supply studies and cost estimates for the dam and reservoir have been made in feasibility detail. The depletion to Bear River from the municipal and industrial water diversion and from evaporation at Honeyville Reservoir is estimated at 38,000 acre-feet annually. Segment water released to the existing ponds of the bird refuge at the river's end would not add significantly to present evaporation from the ponds. As this water flows from the refuge it would be available to appropriators seeking water from Bear River Bay of Great Salt Lake.

Economic and financial appraisal

The construction cost of the Honeyville Segment is estimated at $11,641,000 and the annual operation, maintenance, and replacement cost at $72,900. Only lump sum estimates are made for municipal and industrial water conveyance facilities pending a more definite determination of the place of water use. The costs are itemized below.

	Estimated cost	
Facility	Construction	Annual operation, maintenance, and replacement
Honeyville Dam and Reservoir	$8,130,000	$5,880
Municipal water conveyance facilities	2,408,000	18,720
Recreation facilities	1,085,000	48,300
Fish and wildlife	15,000	
General property	3,000	
Total	11,641,000	72,900

Annual benefits in the amount of $1,067,000 are estimated from the various purposes of the Honeyville Segment as listed on the following page.

Municipal and industrial water	$767,000
Fish and wildlife	221,000
Recreation	218,000
Flood control	4,000
Subtotal	1,210,000
Less loss of agricultural benefits on rights-of-way	143,000
Total	1,067,000

Annual benefits of the project would substantially exceed annual costs, indicating that the project would be economically justified. Under present criteria about 58 percent of the project construction cost would be allocated to municipal and industrial water, 22 percent to fish and wildlife, and 20 percent to recreation. Only a nominal allocation would be made to flood control. In order to pay costs allocated to municipal and industrial water, revenues of about $12.75 per acre-foot for this water would be required. Recreation interests would be required to repay about $550,000 of the construction cost and $50,000 annually to operation, maintenance, and replacement costs. The flood control allocation would be nonreimbursable as would all but a nominal part of the fish and wildlife allocation.